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RESPIRATORY CARE

A MONTHLY SCIENCE JOURNAL
43RD YEAR—ESTABLISHED 1956

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44th International Respiratory Congress
November 7-10, 1998 • Atlanta, Georgia

EDITORIALS

Outcomes Research: Starting to Make Its Mark in Defining Optimal Respiratory Care Practices

The Clinician Meets the Outcomes Researcher

The Invasion of Noninvasive Ventilation: Changing Demographics of Long-Term Mechanical Ventilation

ORIGINAL CONTRIBUTIONS

Changing Patterns of Respiratory Care Service Use in the Era of Respiratory Care Protocols: An Observational Study

Changing Prevalence of Chronically Ventilator-Assisted Individuals in Minnesota: Increases, Characteristics, and the Use of Noninvasive Ventilation

POINTS OF VIEW

Continuous Pulse Oximetry and Patient Outcomes: A Skeptical View

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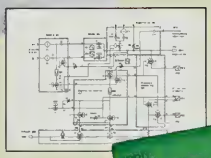

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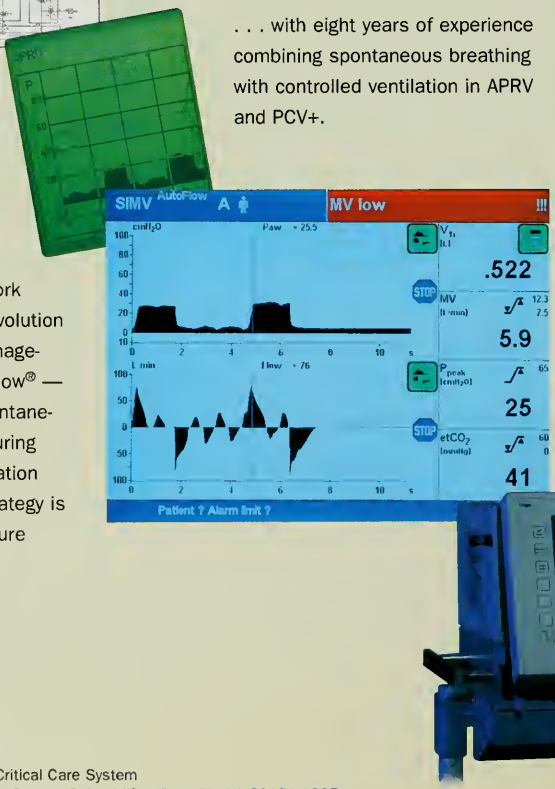

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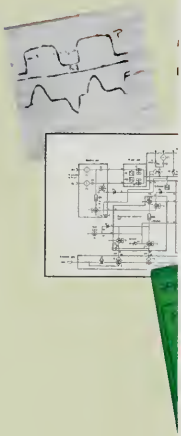

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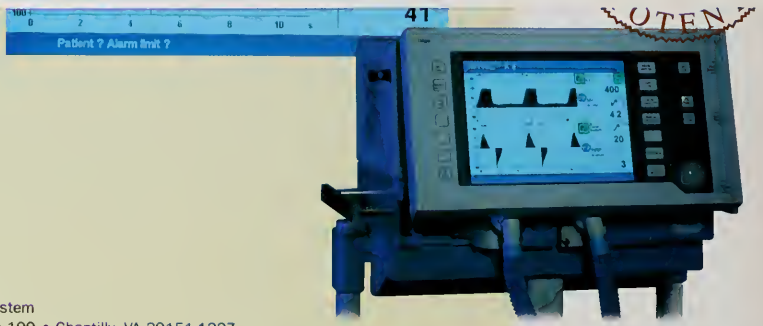

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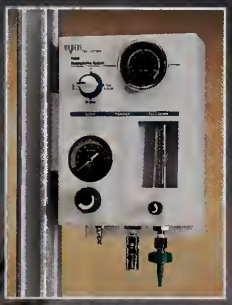

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Heart or Lung Disease: Determining the Primary Cause for Dyspnea on Exertion—Mohnssen SR, Weisman IM, Zeballos RJ, Hall A, Wasserman K, Tavel ME. Chest 1998;113(6):1705–1710.

Reduced Gas Transfer At Rest and during Exercise in School-Age Survivors of Bronchopulmonary Dysplasia—Mitchell SH, Teague WG. Am J Respir Crit Care Med 1998; 157(5 Pt 1):1406.

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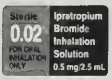

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Immediate hypersensitivity reactions may occur after administration of ipratropium bromide, as demonstrated by rare cases of urticaria, angioedema, rash, bronchospasm and oropharyngeal edema.

PRECAUTIONS: General: Ipratropium bromide should be used with caution in patients with narrow angle glaucoma, prostatic hypertrophy or bladder neck obstruction.

Information for Patients: Patients should be advised that temporary blurring of vision, precipitation or worsening of narrow-angle glaucoma or eye pain may result if the solution comes into direct contact with the eyes. Use of a nebulizer with mouthpiece rather than face mask may be preferable, to reduce the likelihood of the nebulizer solution reaching the eyes. Patients should be advised that Ipratropium Bromide Inhalation Solution can be mixed in the nebulizer with albuterol or metaproterenol if used within one hour. Drug stability and safety of Ipratropium Bromide Inhalation Solution when mixed with other drugs in a nebulizer have not been established. Patients should be reminded that Ipratropium Bromide Inhalation Solution should be used consistently as prescribed throughout the course of therapy.

Drug Interactions: Ipratropium bromide has been shown to be a safe and effective bronchodilator when used in conjunction with beta adrenergic bronchodilators. Ipratropium bromide has also been used with other pulmonary medications, including methylxanthines and corticosteroids, without adverse drug interactions.

Carcinogenesis, Mutagenesis, Impairment of Fertility: Two-year oral carcinogenicity studies in rats and mice have revealed no carcinogenic potential at dietary doses up to 6 mg/kg/day of ipratropium bromide.

Results of various mutagenicity studies (Ames test, mouse dominal lethal test, mouse micronucleus test and chromosome aberration of bone marrow in Chinese hamsters) were negative.

Fertility of male or female rats at oral doses up to 50 mg/kg/day was unaffected by ipratropium bromide administration. At doses above 90 mg/kg, increased resorption and decreased conception rates were observed.

Pregnancy: *TERATOGENIC EFFECTS:*
Pregnancy Category B. Oral reproduction studies performed in mice, rats and rabbits at doses of 10, 100, and 125 mg/kg respectively and inhalation reproduction studies in rats and rabbits at doses of 1.5 and 1.8 mg/kg (or approximately 38 and 45 times the recommended human daily dose) respectively, have demonstrated no evidence of teratogenic effects as a result of ipratropium bromide. However, no adequate or well controlled studies have been conducted in pregnant women. Because animal reproduction studies are not always predictive of human response, ipratropium bromide should be used during pregnancy only if clearly needed.

Nursing Mothers: It is not known whether ipratropium bromide is excreted in human milk. Although lipid-insoluble quaternary bases pass into breast milk, it is unlikely that ipratropium bromide would reach the infant to a significant extent, especially when taken by inhalation since ipratropium bromide is not well absorbed systemically after inhalation or oral administration. However, because many drugs are excreted in human milk, caution should be exercised when ipratropium bromide is administered to a nursing woman.

Pediatric Use: Safety and effectiveness in pediatric patients below the age of 12 have not been established.

ADVERSE REACTIONS: Adverse reaction information concerning Ipratropium Bromide Inhalation Solution is derived from 12-week active-controlled clinical trials. Additional information is derived from foreign post-marketing experience and the published literature.

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All Adverse Events, From a Double-blind, Parallel, 12-week Study of Patients with COPD*

	PERCENT OF PATIENTS				
	Ipratropium Bromide (500 mcg t.i.d.)	Meta-proterenol (15 mg t.i.d.)	Ipratropium / Bromide/ Metaproterenol (500 mcg t.i.d./ 15 mg t.i.d.)	Albuterol (2.5 mg t.i.d.)	Ipratropium Bromide/ Albuterol (500 mcg t.i.d./ 2.5 mg t.i.d.)
	n = 219	n = 212	n = 108	n = 205	n = 100
Body as a Whole-General Disorders					
Headache	6.4	5.2	6.5	6.3	9.0
Pain	4.1	3.3	0.9	2.9	5.0
Influenza-like symptoms	3.7	4.7	6.5	0.5	1.0
Back Pain	3.2	1.9	1.9	2.4	0.0
Chest Pain	3.2	4.2	5.6	2.0	1.0
Cardiovascular Disorders					
Hypertension/ Hypertension Aggravated	0.9	1.9	0.9	1.5	4.0
Central & Peripheral Nervous System					
Dizziness	2.3	3.3	1.9	3.9	4.0
Insomnia	0.9	0.5	4.6	1.0	1.0
Tremor	0.9	7.1	8.3	1.0	0.0
Nervousness	0.5	4.7	6.5	1.0	1.0
Gastrointestinal System Disorders					
Mouth Dryness	3.2	0.0	1.9	2.0	3.0
Nausea	4.1	3.8	1.9	2.9	2.0
Constipation	0.9	0.0	3.7	1.0	1.0
Musculo-skeletal System Disorders					
Arthritis	0.9	1.4	0.9	0.5	3.0
Respiratory System Disorders (Lower)					
Coughing	4.6	8.0	6.5	5.4	6.0
Dyspnea	9.6	13.2	16.7	12.7	9.0
Bronchitis	14.6	24.5	15.7	16.6	20.0
Bronchospasm	2.3	2.8	4.6	5.4	5.0
Sputum Increased	1.4	1.4	4.6	3.4	0.0
Respiratory Disorder	0.0	6.1	6.5	2.0	4.0
Respiratory System Disorders (Upper)					
Upper Respiratory Tract Infection	13.2	11.3	9.3	12.2	16.0
Pharyngitis	3.7	4.2	5.6	2.9	4.0
Rhinitis	2.3	4.2	1.9	2.4	0.0
Sinusitis	2.3	2.8	0.9	5.4	4.0

*All adverse events, regardless of drug relationship, reported by the three percent or more patients in the 12-week controlled clinical trials

Additional adverse reactions reported in less than three percent of the patients treated with ipratropium bromide include tachycardia, palpitations, eye pain, urinary retention, urinary tract infection and urticaria. Cases of precipitation or worsening of narrow-angle glaucoma and acute eye pain have been reported.

Lower respiratory adverse reactions (bronchitis, dyspnea and bronchospasm) were the most common events leading to discontinuation of ipratropium bromide therapy in the 12-week trials. Headache, mouth dryness and aggravation of COPD symptoms are more common when the total daily dose of ipratropium bromide equals or exceeds 2,000 mcg.

Allergic-type reactions such as skin rash, angioedema of tongue, lips and face, urticaria, laryngospasm and anaphylactic reaction have been reported. Many of the patients had a history of allergies to other drugs and/or foods.

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either by long-term derangements in lung structure or residual right ventricular dysfunction affecting cardiac output.

Detection of Flow Limitation with a Nasal Cannula/Pressure Transducer System—Hosselet JJ, Norman RG, Ayappa I, Rapoport DM. Am J Respir Crit Care Med 1998;157(5 Pt 1):1461.

We previously showed that upper airway resistance can be inferred from the inspiratory flow contour during continuous positive airway pressure (CPAP) titration in obstructive sleep apnea syndrome (OSAS). The present study examines whether similar information can be obtained from inspiratory flow measured by a nasal cannula/pressure transducer. Ten symptomatic patients (snoring, upper airway resistance syndrome [UARS], or OSAS) and 4 asymptomatic subjects underwent nocturnal polysomnography (NPSG) with monitoring of flow (nasal cannula) and respiratory driving pressure (esophageal or supraglottic catheter). For each breath the inspiratory flow signal was classified as normal, flattened, or intermediate by custom software. "Resistance" was calculated from peak inspiratory flow and pressure, and normalized to the resistance during quiet wakefulness. Resistance in all stages of sleep was increased for breaths with flattened (387 ± 188%) or intermediate (292 ± 163%) flow contour. In combination with apnea-hypopnea index (AHI), identification of "respiratory events," consisting of consecutive breaths with a flattened contour, allowed differentiation of symptomatic from asymptomatic subjects. Our data show that development of a plateau on the inspiratory flow signal from a nasal cannula identifies increased upper airway resistance and the presence of flow limitation. In patients with symptoms of excessive daytime somnolence and low AHI this may help diagnose the UARS and separate it from nonrespiratory causes of sleep fragmentation.

General Exercise Training Improves Ventilatory and Peripheral Muscle Strength and Endurance in Chronic Airflow Limitation—O'Donnell DE, McGuire M, Samis L, Webb KA. Am J Respir Crit Care Med 1998;157(5 Pt 1):1489.

We studied the impact of a 6-week supervised, multimodality endurance exercise training program (EXT) on strength and endurance of ventilatory and peripheral muscles in patients with chronic airflow limitation (CAL), and determined whether potential improvements contributed to relief of exertional breathlessness (B) and perceived leg effort/discomfort (LE), respectively. Twenty breathless patients with stable CAL (FEV_1 = 41 ± 3% predicted; mean ± SEM) were tested at 6-week intervals at baseline, after a nonintervention control period (pre-EXT), and post-EXT. Measurements included: pulmonary function tests (PFTs), maximal inspiratory/expiratory pressures (MIP, MEP), inspiratory muscle endurance (V_{LIM}), quadriceps strength and endurance, exercise endurance, and submaximal cycle exercise with cardioventilatory and symptom responses. Measurements at baseline and pre-EXT were identical. Post-EXT, PFTs did not change; exercise endurance measured on the treadmill, cycle ergometer, arm ergometer, and by 6-min walk distance increased 40 ± 8%, 43 ± 10%, 12 ± 5%, and 34 ± 9%, respectively ($p < 0.05$); quadriceps strength increased 21 ± 5% ($p < 0.01$); MIP and MEP increased 29 ± 11% and 27 ± 11%, respectively ($p < 0.05$); V_{LIM} increased almost threefold ($p < 0.05$). At isotime near end-exercise, B, LE, carbon dioxide production (V_{CO_2}), oxygen consumption (V_{O_2}), ventilation, and breathing frequency (f) all fell after EXT ($p < 0.05$); ΔB correlated with Δf ($r = 0.58$, $p < 0.01$). Increased MIP and V_{LIM} did not correlate with improved breathlessness or exercise endurance. Similarly, changes in quadriceps strength and endurance did not correlate with changes in LE or exercise endurance. In conclusion, general nonspecific EXT improved ventilatory and peripheral muscle function in severe CAL, but such improvements did not appear to contribute significantly to reduced exertional symptoms and enhanced exercise performance.

Effect of Exacerbation on Quality of Life in Patients with Chronic Obstructive Pulmonary Disease—Seemungal TA, Donaldson GC, Paul EA, Bestall JC, Jeffries DJ, Wedzicha JA. Am J Respir Crit Care Med 1998;157(5 Pt 1):1418.

Exacerbations occur commonly in patients with moderate or severe chronic obstructive pulmonary disease (COPD), but factors affecting their severity and frequency or effects on quality of life are unknown. We measured daily peak expiratory flow rate (PEFR) and daily respiratory symptoms for 1 year in 70 COPD patients (52 male, 18 female, mean age [±SD] 67.5 ± 8.3 yr, FEV_1 1.06 ± 0.45 L, FVC 2.48 ± 0.82 L, FEV_1/FVC 44 ± 15%, FEV_1 reversibility 6.7 ± 9.1%, P_{aO_2} 8.8 ± 1.1 kPa). Quality of life was measured by the St George's Respiratory Questionnaire (SGRQ). Exacerbations (E) were assessed at acute visit (reported exacerbation) or from diary card data each month (unreported exacerbation). In 61 (87%) patients there were 190 exacerbations (median 3; range, 1 to 8) of which 93 (51%) were reported. There were no differences in major symptoms (increase in dyspnea, sputum volume, or purulence) or physiological parameters between reported and unreported exacerbations. At exacerbation, median peak flow fell by an average of 6.6 L/min ($p = 0.0003$). Using the median number of exacerbations as the cutoff point, patients were classified as infrequent exacerbators (E = 0 to 2) or frequent exacerbators (E = 3 to 8). The SGRQ Total and component scores were significantly worse in the group that had frequent exacerbations: SGRQ Total score (mean difference = 14.8, $p < 0.001$), Symptoms (23.1, $p < 0.001$), Activities (12.2, $p = 0.003$), Impacts (13.9, $p = 0.002$). However there was no difference between frequent and infrequent exacerbators in the fall in peak flow at exacerbation. Factors predictive of frequent exacerbations were daily cough ($p = 0.018$), daily wheeze ($p = 0.011$), and daily cough and sputum ($p = 0.009$) and frequent exacerbations in the previous year ($p = 0.001$). These findings suggest that patient quality of life is related to COPD exacerbation frequency.

Surface Tension Forces in Sleep Apnea: the Role of a Soft Tissue Lubricant: A Randomized Double-Blind, Placebo-Controlled Trial—Jokic R, Klimaszewski A, Mink J, Fitzpatrick MF. Am J Respir Crit Care Med 1998; 157(5 Pt 1):1522.

Upper airway obstruction in patients with sleep apnea may occur in the absence of a negative intraluminal upper airway pressure. We hypothesized that surface tension forces may play a role in the pathogenesis of obstructive sleep apnea (OSA), and that a topical soft tissue lubricant might reduce the severity of OSA. Ten male patients (age 49 ± 10 y [mean ± SD]; body mass index [BMI] 31 ± 5 kg/m^2) with OSA (apnea-hypopnea index [AHI] 17 ± 9) were studied. The arousal index was lower with the lubricant treatment than with placebo (mean difference 8; 95% CI 4–11 arousals/h; $p = 0.001$). The AHI was lower in each of the 10 patients on the lubricant treatment than the placebo (mean change 10, 95% CI 6–13; $p = 0.0003$). The lower AHI with lubricant as compared with placebo was present in both supine (mean difference 13; 95% CI 5–20; $p = 0.006$) and nonsupine (mean difference 6; 95% CI 0–12; $p = 0.05$) positions. There was no significant difference in sleep architecture between the lubricant and placebo treatments. Application of a topical lubricant consistently reduced the severity of OSA. This implies a pathogenetic role for surface tension forces in OSA, and a potential role for surface tension-reducing agents in the treatment of OSA.

Inhaled Nitric Oxide versus Conventional Therapy: Effect on Oxygenation in ARDS—Michael JR, Barton RG, Saffle JR, Mone M, Markewitz BA, Hillier K, et al. Am J Respir Crit Care Med 1998;157(5 Pt 1):1372.

A randomized, controlled clinical trial was performed with patients with acute respiratory distress syndrome (ARDS) to compare the effect of conventional therapy or inhaled nitric oxide (iNO) on oxygenation. Patients were randomized to either conventional therapy or conventional therapy plus iNO for 72 h. We tested the

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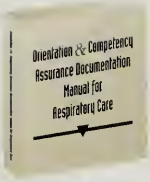

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following hypotheses: (1) that iNO would improve oxygenation during the 72 h after randomization, as compared with conventional therapy; and (2) that iNO would increase the likelihood that patients would improve to the extent that the F_{IO_2} could be decreased by $\geq$ 0.15 within 72 h after randomization. There were 2 major findings. First, that iNO as compared with conventional therapy increased P_{aO_2}/F_{IO_2} at 1 h, 12 h, and possibly 24 h. Beyond 24 h, the 2 groups had an equivalent improvement in P_{aO_2}/F_{IO_2}. Second, that patients treated with iNO therapy were no more likely to improve so that they could be managed with a persistent decrease in $F_{IO_2} \geq 0.15$ during the 72 h following randomization (11 of 20 patients with iNO versus 9 of 20 patients with conventional therapy, $p = 0.55$). In patients with severe ARDS, our results indicate that iNO does not lead to a sustained improvement in oxygenation as compared with conventional therapy.

Fatal Air Embolism in an Airplane Passenger with a Giant Intrapulmonary Bronchogenic Cyst—Zaugg M, Kaplan V, Widmer U, Baumann PC, Russi EW. Am J Respir Crit Care Med 1998;157(5 Pt 1):1686.

Considering the large number of airplane passengers with a variety of medical conditions, the incidence of in-flight emergencies on commercial airline flights is low. Only a few cases of pulmonary barotrauma in airplane passengers with prior lung pathologies have been reported. We present the unusual case of a female airplane passenger with a previously diagnosed asymptomatic giant intrapulmonary bronchogenic cyst who experienced fatal air embolism on a commercial airline flight. We believe that preventive surgical resection is mandatory in asymptomatic patients with large intrapulmonary cysts prior to exposure to even small alterations in ambient pressure as, for instance, prior to airplane flight or use of mountain cable cars. However, screening for pre-existent lung pathologies in the growing mass of commercial airline travelers is not justified.

A "Closed" Medical Intensive Care Unit (MICU) Improves Resource Utilization when Compared with an "Open" MICU—Multz AS, Chalfin DB, Samson IM, Dantzker DR, Fein AM, Steinberg HN, et al. Am J Respir Crit Care Med 1998;157(5 Pt 1):1468.

We hypothesized that a "closed" intensive care unit (ICU) was more efficient that an "open" one. ICU admissions were retrospectively analyzed before and after ICU closure at one hospital; prospective analysis in that ICU with an open ICU nearby was done. Illness severity was gauged by the Mortality Prediction Model (MPMO). Outcomes included mortality, ICU length of stay (LOS), hospital LOS, and mechanical ventilation (MV). There were no differences in age, MPMO, and use of MV. ICU and hospital LOS were lower when "closed" (ICU LOS: prospective 6.1 vs 12.6 d, $p < 0.0001$; retrospective 6.1 vs 9.3 d, $p < 0.05$; hospital LOS: prospective 19.2 vs 33.2 d, $p < 0.008$; retrospective 22.2 vs 31.2 d, $p < 0.02$). Days on MV were lower when "closed" (prospective 2.3 vs 8.5 d, $p < 0.0005$; retrospective 3.3 vs 6.4 d, $p < 0.05$). Pooled data revealed the following: MV predicted ICU LOS; ICU organization and MPMO predicted days on MV; MV and ICU organization predicted hospital LOS; mortality predictors were open ICU (odds ratio [OR] 1.5, $p < 0.04$), MPMO (OR 1.16 for MPMO increase 0.1, $p < 0.002$), and MV (OR 2.43, $p < 0.0001$). We conclude that patient care is more efficient with a closed ICU, and that mortality is not adversely affected.

Inhaled Nitric Oxide in Acute Respiratory Distress Syndrome: A Pilot Randomized Controlled Study—Troncy E, Collet JP, Shapiro S, Guimond JG, Blair L, Ducruet T, et al. Am J Respir Crit Care Med 1998;157(5 Pt 1):1483.

This pilot randomized controlled clinical trial of patients with ARDS was implemented to study the impact of inhaled nitric oxide (inhNO) on lung function, morbidity, and mortality. Thirty patients with ARDS were randomly allocated to usual care or usual care plus inhNO. The optimal dose of inhNO was determined to be between 0.5 and 40 ppm daily. All therapeutic interventions were standardized. ARDS resulted mainly from sepsis (25 of the 30). During the first 24 hours, the hypoxia score increased greatly in patients treated with inhNO + 70.4 mm Hg (+59%) versus +14.2 mm Hg (+9.3%) for the control group ($p = 0.02$), venous admixture decreased from 25.7 to 15.2% in the inhNO group, and from only 19.4 to 14.9% in the control group ($p = 0.05$). After the first day of therapy no further beneficial effect of inhNO was detected. Forty percent of the patients treated with inhNO were alive and weaned from mechanical ventilation within 30 days after randomization compared with 33.3% in the control group ($p = 0.83$). The 30-day mortality rate was similar in the two groups; most deaths (11 of 17) were due to multiple organ dysfunction syndrome. This study shows that inhNO, in this population, may improve gas exchange but does not affect mortality.

Bronchial Microbial Patterns in Severe Exacerbations of Chronic Obstructive Pulmonary Disease (COPD) Requiring Mechanical Ventilation—Soler N, Torres A, Ewig S, Gonzalez J, Celis R, El-Ebiary M, et al. Am J Respir Crit Care Med 1998;157(5 Pt 1):1498.

We carried out a comprehensive microbiological study of the upper and lower airways in patients with severe exacerbations of chronic obstructive pulmonary disease (COPD) requiring mechanical ventilation in order to describe microbial patterns and analyze their clinical significance. Quantitative cultures of tracheobronchial aspirates (TBAs), bronchoscopically retrieved protected specimen brush (PSB) and bronchoalveolar lavage fluid (BALF) at admission to the ICU and after 72 hours, as well as serology for bacteria and respiratory viruses were performed. Fifty patients (mean age 68 ± 8, 46 males) were studied prospectively. Potentially pathogenic microorganisms (PPMs) and/or a positive serology were present in 36 of 50 (72%) patients, including 12 (33%) polymicrobial cases. Only 6 (12%) had no pathogen in any sample in the absence of antimicrobial pretreatment. Microbial patterns corresponded to community-acquired pathogens (*Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis*) in 19 of 34 (56%) and to Gram-negative enteric bacilli (GNEB), *Pseudomonas*, and *Stenotrophomonas spp.* in 15 of 34 (44%) of isolates. *Chlamydia pneumoniae* and respiratory viruses were found in 18% and 16% of investigations, respectively. Repeated investigation after 72 hours in 19 patients with PPMs in the initial investigation revealed eradication of virtually all isolates of community-acquired pathogens and GNEB but persistence of three of five *Pseudomonas spp* and both *Stenotrophomonas spp* as well as the emergence of new GNEB, *Pseudomonas* and *Stenotrophomonas spp.* Clinical parameters neither predicted the presence of PPMs nor of GNEB and *Pseudomonas/Stenotrophomonas spp.* Nevertheless, severe pneumonia attributable to initially isolated pathogens occurred in 2 patients with severe COPD exacerbation. We conclude that pathogens were more frequently present than previously reported. The rate of GNEB and *Pseudomonas/Stenotrophomonas* spp isolates was high. The presence of pathogens was clinically unpredictable. Thus, in this population of patients with severe exacerbations of COPD, it may be advisable to obtain respiratory samples and to treat according to diagnostic results. Further studies are warranted to clarify this issue.

Validation of a Predictive Model for Postoperative Pulmonary Complications—Brooks-Brunn JA. Heart Lung 1998;27(3):151.

OBJECTIVE: To test or validate a previously reported model for predicting postoperative pulmonary complications (PPCs) after elective abdominal surgical procedures. DESIGN: Prospective, descriptive. SETTING: Four midwestern hospitals serving a diverse population of patients. PATIENTS: Two hundred seventy-six adult patients who had undergone abdominal surgery (51% men, 49% women; mean age 54.1 ± 5.3 years). OUTCOME MEASURES: PPC developed in 26.4%. DATA COLLECTION: Data were collected preoperatively during a brief interview and a pulmonary physical

examination and on the first 6 postoperative days. RESULTS: A six risk-factor model was tested in this sample of subjects. The model validated relatively well in the sample of 276 subjects with use of the basic criteria of correct classification, sensitivity, and specificity. However, when a new model was developed from this sample, differing risk factors emerged as significant independent predictors. CONCLUSIONS: Further research is needed to assess the stability of the risk factors and test the models in differing settings and populations of patients.

Development and Testing of the Modified Version of the Pulmonary Functional Status and Dyspnea Questionnaire (PFSDQ-M)—Lareau SC, Meek PM, Roos PJ. Heart Lung 1998;27(3):159.

OBJECTIVE: Describe the process of development and testing to reduce the Pulmonary Functional Status and Dyspnea Questionnaire (PFSDQ) from 164 items to a modified questionnaire (the PFSDQ-M) consisting of 40 items. DESIGN: Instrument development and testing for reliability, validity, and practicality. SETTING: Hospital-based outpatients. PATIENTS: Testing was done on 3 groups of clinically stable patients with chronic obstructive pulmonary disease: a secondary analysis of 131 subjects for item selection, reliability, and validity; 50 additional subjects evaluating the PFSDQ-M for internal consistency, test-retest correlations, and construct validity; and 34 subjects from a longitudinal study for responsiveness. OUTCOME MEASURES: PFSDQ, PFSDQ-M, and spirometry. RESULTS: The practicality of the PFSDQ-M was supported by its sixth- to seventh-grade reading level, ease of reading (Flesch-Kincaid 69.5), self-administration, brief period for testing (7 min initially, 6 min on repeated testing), and limited missing data (<8%). Reliability of the 3 components was supported by internal consistency $\alpha = 0.93$ for change experienced by the patient with activities (CA), 0.95 for dyspnea with activities (DA), and 0.95 for fatigue with activities (FA). Good stability of the PFSDQ-M was demonstrated on test-retest; $r = 0.70$ for change, 0.83 for dyspnea, and 0.79 for fatigue (with activities). The usefulness of the PFSDQ-M in discriminating between dyspnea scores in patients based on their rate of deterioration in lung function was demonstrated. CONCLUSIONS: The PFSDQ was modified by reducing the number of activities evaluated, standardizing scaling formats, and adding a fatigue component. Findings suggest that the PFSDQ-M demonstrates initial reliability; good validity estimates, as seen with the factor analysis, and the dyspnea and activity scores appear responsive to physiologic changes in lung function over time.

Effectiveness of a Music Therapy Intervention on Relaxation and Anxiety for Patients Receiving Ventilatory Assistance—Chlan L. Heart Lung 1998;27(3):169.

OBJECTIVE: To test the effects of music therapy on relaxation and anxiety reduction for patients receiving ventilatory assistance. DESIGN: Two-group, pretest-posttest experimental design with repeated measures. Subjects randomized to either a 30-min music condition or a rest period. SETTING: Four urban midwestern intensive care units. SUBJECTS: Fifty-four alert, nonsedated patients receiving mechanical ventilation. OUTCOME MEASURES: State anxiety (pretest and posttest), heart rate, and respiratory rate obtained every 5 min for 30 min. RESULTS: Subjects who received music therapy reported significantly less anxiety posttest (10.1) than those subjects in the control group (16.2). Heart rate and respiratory rate decreased over time for those subjects in the music group as compared with the control group subjects. CONCLUSIONS: A single music therapy session was found to be effective for decreasing anxiety and promoting relaxation, as indicated by decreases in heart rate and respiratory rate over the intervention period with this sample of patients receiving ventilatory assistance.

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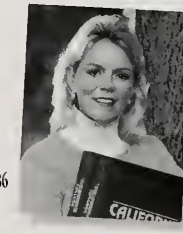

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Chou KJ, et al, *Arch Pediatr Adolesc Med.* 1995; 149:201-205

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Patient Perception of Fatigue while Undergoing Long-Term Mechanical Ventilation: Incidence and Associated Factors—Higgins PA. Heart Lung 1998;27(3):177.

OBJECTIVE: To describe a chronically critically ill population of patients receiving long-term ventilatory assistance, including patient perception of fatigue and the associated factors of nutritional status, depression, and sleep-rest. DESIGN: Prospective, descriptive correlational design. SETTING: Two tertiary care, university-affiliated medical centers. SUBJECTS: Twenty subjects who were undergoing mechanical ventilation for at least 7 days and who were in the process of weaning. RESULTS: Descriptive, correlational, and *t* test statistics were used in the data analysis. There was a 100% prevalence rate of fatigue, and with a 10-cm visual analogue scale, 45% of the subjects rated their fatigue as severe (≥6.0 cm) in intensity. The sample's mean serum albumin was 2.7 gm/dL, and mean hemoglobin was 10.1 gm/dL, but there were no statistically significant relationships between fatigue and nutritional status. Subjects' depression scores were in the moderate range, and they evaluated their sleep as fragmented and only moderately effective. Fatigue and depression were strongly correlated ($r = 0.61$; $p = 0.004$); there were no statistically significant relationships between fatigue and the sleep-rest scales. CONCLUSIONS: The descriptive findings suggest that patients receiving long-term ventilatory assistance are undernourished and experience fatigue, depressed mood state, and disruptions of their sleep-rest patterns.

Nonoccupational Exposure to Chrysotile Asbestos and the Risk of Lung Cancer—Camus M, Siemiatycki J, Meek B. N Engl J Med 1998;338(22):1565.

BACKGROUND: Heavy industrial exposure to asbestos causes lung cancer and mesothelioma, but it remains unknown whether much lower environmental exposure to asbestos also causes these cancers. Nevertheless, regulatory agencies, including the Environmental Protection Agency (EPA), have assessed the risk of lung cancer by extrapolating known risks from past industrial exposure to asbestos to today's much lower environmental asbestos levels (roughly 100,000 times lower). We also tested the EPA's model for predicting the risk of asbestos-induced lung cancer in a population of women with relatively high levels of nonoccupational exposure to asbestos. METHODS: Mortality among women in 2 chrysotile-asbestos-mining areas of the province of Quebec was compared with mortality among women in 60 control areas, and age-standardized mortality ratios were derived. With the help of an expert panel, we estimated past exposure to asbestos among women in the mining areas and used these data with the EPA's model to predict the relative risk of lung cancer. We then compared this prediction with the observed mortality ratios. RESULTS: On the basis of the estimated exposure in the asbestos-mining areas, a relative risk of death due to lung cancer of 2.1 was predicted by the EPA's model, amounting to about 75 excess deaths from lung cancer in this population. By contrast, we calculated a standardized mortality ratio of 1.0 and a standardized proportionate mortality ratio of 1.1 ($p > 0.05$), suggesting that there were between 0 and 6.5 excess deaths from lung cancer among the women with nonoccupational exposure to asbestos. Seven deaths from pleural cancer were observed (relative risk = 7.63; $p < 0.05$). CONCLUSIONS: We found no measurable excess risk of death due to lung cancer among women in two chrysotile-asbestos-mining regions. The EPA's model overestimated the risk of asbestos-induced lung cancer by at least a factor of 10.

Communicating Do-Not-Resuscitate Orders with a Computer-Based System—Heffner JE, Barbieri C, Fracica P, Brown LK. Arch Intern Med 1998;158(10):1090.

BACKGROUND: Do-not-resuscitate (DNR) orders for critically ill patients are frequently miscommunicated between attending physicians, house staff, and nurses. A computer-based

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system was developed to improve the communication of a procedure-specific DNR order form. METHODS: Concordance of understanding of patients' DNR status was measured with the use of unstructured DNR orders (Period 1), procedure-specific DNR order forms (Period 2), and procedure-specific DNR order forms administered with a computer-based communication system (Period 3). The 3 components of the DNR order assessed were (1) the clinical events to which the DNR order applied, (2) whether the DNR order withheld all elements of cardiopulmonary resuscitation, and (3) whether other treatments were to be withheld. RESULTS: For the 147 patients, the computer-based system in Period 3 (n = 71) improved concordance for attending physicians and nurses or residents for all 3 of the DNR components compared with Period 1 (n = 40) and some of the DNR components compared with Period 2 (n = 36). Concordance was "substantial" or "almost perfect" as measured by the K statistic during Period 3. The proportion of agreement for the composite of all 3 components of the DNR order increased during each period ($p < 0.001$, Period 3 vs Period 1). Overall agreement between all caregivers for the composite DNR order also improved from Period 1 (22.2%) to Period 2 (47.8%) and Period 3 (61.9%; $p < 0.001$ vs Period 1). Errors in order entry were detected by physicians because of the computer system and corrected in 9.9% of DNR orders in Period 3. Progress note documentation of DNR status did not improve during Period 3. The procedures of Period 3 were considered acceptable by the physician and nursing staff. CONCLUSION: A computer-based system combined with a procedure-specific DNR order form improves communication of patients' DNR status in a critical care setting.

Exposure of Young Infants to Environmental Tobacco Smoke: Breast-Feeding among Smoking Mothers—Mascola MA, Van Vunakis H, Tager IB, Speizer FE, Hanrahan JP. Am J Public Health 1998;88(6):893.

OBJECTIVES: This study examined the degree to which breast-feeding and cigarette smoking by mothers and smoking by other household members contribute to the exposure of infants to the products of tobacco smoke. METHODS: The subjects were 330 mother-infant pairs derived from a cohort of 1,000 pairs enrolled in a longitudinal study of the pulmonary effects of prenatal and postnatal smoking. The main outcome measure was corrected urinary cotinine levels. RESULTS: Urinary cotinine levels were 10-fold higher in breast-fed infants of smoking mothers than among bottle-fed infants of smoking mothers. Among infants of nonsmoking mothers, urine cotinine levels were significantly increased in infants living in homes with other smokers; in this group there was no significant difference between bottle-fed and breast-fed infants. Infants whose mothers smoked in the same room as the infant had only nonsignificant increases in cotinine levels compared with infants whose mothers restricted their smoking to other rooms. CONCLUSIONS: Breast-fed infants of smoking mothers have urine cotinine levels 10-fold higher than bottle-fed infants whose mothers smoke, suggesting that breast-feeding, rather than direct inhalation of environmental tobacco smoke, is the primary determinant of cotinine levels in infants whose mothers smoke.

Use of Intensive Care Units for Patients with Low Severity of Illness—Rosenthal GE, Sirio CA, Shepardson LB, Harper DL, Rotondi AJ, Cooper GS. Arch Intern Med 1998;158(10):1144.

OBJECTIVE: To determine variations among hospitals in use of intensive care units (ICUs) for patients with low severity of illness. DESIGN: Retrospective cohort study. SETTING: Twenty-eight hospitals with 44 ICUs in a large metropolitan region. PATIENTS: Consecutive eligible patients (n = 104,487) admitted to medical, surgical, neurological, or mixed medical-surgical ICUs from March 1, 1991, to March 31, 1995. OUTCOME MEASURES: The pre-

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dicted risk of in-hospital death for each patient was assessed using a validated method that is based on age, ICU admission source, diagnosis, severe comorbid conditions, and abnormalities in 17 physiologic variables. Admissions were classified as low severity if the patient's predicted risk of death was <1%. In a subset of 12,929 consecutive patients, use of 19 specific interventions typically delivered in ICUs was examined. RESULTS: Twenty thousand four hundred fifty-one admissions (19.6%) were categorized as low severity, including 23.6% of postoperative and 16.9% of nonoperative admissions. Alcohol and other drug overdoses accounted for 40.2% of nonoperative low-severity admissions; laminectomy and carotid endarterectomy accounted for 52.3% of postoperative low-severity admissions. Mortality among patients with low-severity illness was 0.3%, and only 28.6% received an ICU-specific intervention during the first ICU day. Although mean ICU length of stay was shorter ($p < 0.001$) in low-severity admissions (2.2 vs 4.7 days in nonoperative and 2.4 vs 4.2 days in postoperative admissions), low-severity admissions accounted for 11.1% of total ICU bed days. Rates of low-severity admissions varied ($p < 0.001$) across hospitals, ranging from 5% to 27% for nonoperative and 9% to 68% for postoperative admissions. CONCLUSIONS: A large proportion of patients admitted to the ICU have a low probability of death and do not receive ICU-specific interventions. Rates of low-severity admissions varied among hospitals. The development and implementation of protocols to target ICU care to patients most likely to benefit may decrease the number of low-severity ICU admissions and improve the cost-effectiveness of ICU care.

Nebulized Budesonide and Oral Dexamethasone for Treatment of Croup: A Randomized Controlled Trial—Klassen TP, Craig WR, Moher D, Osmond MH, Pasterkamp H, Sutcliffe T, et al. JAMA 1998;279(20):1629.

CONTEXT: The effectiveness of glucocorticoids for patients with croup is well established but it remains uncertain which glucocorticoid regimen is most effective. OBJECTIVE: To determine the effectiveness of 3 glucocorticoid regimens in patients with croup. DESIGN: Randomized controlled trial with parallel design. SETTING: Emergency departments of 2 Canadian pediatric tertiary care hospitals. PARTICIPANTS: Children with a clinical syndrome consistent with croup, aged 3 months to 5 years, with a croup score of 2 or greater following at least 15 minutes of mist therapy. INTERVENTIONS: Oral dexamethasone, 0.6 mg/kg, and nebulized placebo; oral placebo and nebulized budesonide, 2 mg; or oral dexamethasone, 0.6 mg/kg, and nebulized budesonide, 2 mg. MAIN OUTCOME MEASURES: Westley croup score (primary outcome), hospital admis-

sion rates, time spent in the emergency department, return visits to the emergency department, or ongoing symptoms at 1 week. RESULTS: The mean change in the croup score from baseline to the final study assessment was −2.3 (95% confidence interval [CI], −2.6 to −2.0) in the budesonide group (n = 65), −2.4 (95% CI, −2.6 to −2.2) in the dexamethasone group (n = 69), and −2.4 (95% CI, −2.7 to −2.1) in the budesonide and dexamethasone group (n = 64, p = 0.70). CONCLUSIONS: Based on the similar outcomes in the 3 groups, oral dexamethasone is the preferred intervention because of its ease of administration, lower cost, and more widespread availability.

How Much Oxygen Does the Human Lung Consume?—Loer SA, Scheeren TW, Tarnow J. Anesthesiology 1997;86(3):532.

BACKGROUND: The amount of oxygen consumed by the lung itself is difficult to measure because it is included in whole-body gas exchange. It may be increased markedly under pathological conditions such as lung infection or adult respiratory distress syndrome. To estimate normal oxygen consumption of the human lung as a basis for further studies, respiratory gas analysis during total cardiopulmonary bypass may be a simple approach because the pulmonary circulation is separated from systemic blood flow during this period. METHODS: Lung oxygen consumption was determined in 16 patients undergoing cardiac surgery. During total cardiopulmonary bypass their lungs were ventilated with low minute volumes tidal volume, 150 mL; rate, 6 min^{-1}; inspiratory oxygen fraction, 0.5; positive end-expiratory pressure, 3 mm Hg. All expiratory gas was collected and analyzed by indirect calorimetry. As a reference value also, whole-body oxygen consumption of these patients was determined before total cardiopulmonary bypass. In a pilot study of 8 additional patients (same ventilatory pattern), the contribution of systemic (bronchial) blood flow to pulmonary gas exchange during cardiopulmonary bypass was assessed. For this purpose, the amount of enflurance diffusing from the systemic blood into the bronchial system was measured. RESULTS: The human lung consumes about 5–6 mL oxygen/min at an esophageal temperature of 28° C. Prebypass whole-body oxygen consumption measured at nearly normothermic conditions was 198 ± 28 mL/min. Mean lung and whole-body respiratory quotients were similar (0.84 and 0.77, respectively). Extrapolating lung oxygen consumption to 36° C suggests that the lung consumes about 11 mL/min or about 5% of total body oxygen consumption. Because the amount of enflurane diffused from the systemic circulation into the bronchial system during cardiopulmonary bypass was <0.1%, the contribution of bronchial blood flow to lung gas exchange can be assumed to be negligible. CONCLUSIONS: The lung consumes about 5% of whole-body oxygen uptake.

Comparison of Cuffed and Uncuffed Endotracheal Tubes in Young Children during General Anesthesia—Khine HH, Corddry DH, Kettrick RG, Martin TM, McCloskey JJ, Rose JB, et al. Anesthesiology 1997;86(3):627.

BACKGROUND: Uncuffed endotracheal tubes are routinely used in young children. This study tests a formula for selecting appropriately sized cuffed endotracheal tubes and compares the use of cuffed versus uncuffed endotracheal tubes for patients whose lungs are mechanically ventilated during anesthesia. METHODS: Full-term newborns and children (n = 488) through 8 years of age who required general anesthesia and tracheal intubation were assigned randomly to receive either a cuffed tube sized by a new formula [size(mm internal diameter) = (age/4) + 3], or an uncuffed tube sized by the modified Cole's formula [size(mm internal diameter) = (age/4) + 4]. The number of intubations required to achieve an appropriately sized tube, the need to use >2 $L \cdot min^{-1}$ fresh gas flow, the concentration of nitrous oxide in the operating room, and the incidence of croup were compared. RESULTS: Cuffed tubes selected by our formula were appropriate for 99% of patients. Uncuffed tubes selected by Cole's formula were appropriate for 77% of patients ($p < 0.001$). The lungs of patients with cuffed tubes were adequately ventilated with 2 $L \cdot min^{-1}$ fresh gas flow, whereas 11% of those with uncuffed tubes needed greater fresh gas flow ($p < 0.001$). Ambient nitrous oxide concentration exceeded 25 ppm in 37% of cases with uncuffed tubes and in 0% of cases with cuffed tubes ($p < 0.001$). Three patients in each group were treated for croup symptoms (1.2% cuffed; 1.3% uncuffed). CONCLUSIONS: Our formula for cuffed tube selection is appropriate for young children. Advantages of cuffed endotracheal tubes include avoidance of repeated laryngoscopy, use of low fresh gas flow, and reduction of the concentration of anesthetics detectable in the operating room. We conclude that cuffed endotracheal tubes may be used routinely during controlled ventilation in full-term newborns and children during anesthesia.

Inaccuracies of Nitric Oxide Delivery Systems during Adult Mechanical Ventilation—Imanaka H, Hess D, Kirmse M, Bigatello LM, Kacmarek RM, Steudel W, Hurford WE. Anesthesiology 1997;86(3):676.

BACKGROUND. Various systems to administer inhaled nitric oxide (NO) have been used in patients and experimental animals. We used a lung model to evaluate 5 NO delivery systems during mechanical ventilation with various ventilatory patterns. METHODS: An adult mechanical ventilator was attached to a test lung configured to separate inspired and expired gases. Four injection systems were evaluated with NO injected either into the inspiratory circuit 90 cm proximal to the Y piece or directly at the Y piece and delivered either continuously or only during the inspiratory phase. Alternatively, NO was mixed with air using a blender and delivered to the high-pressure air inlet of the ventilator. Nitric oxide concentration was measured from the inspiratory limb of the ventilator circuit and the tracheal level using rapid- and slow-response chemiluminescence analyzers. The ventilator was set for constant-flow volume control ventilation, pressure control ventilation, pressure support ventilation, or synchronized intermittent mandatory ventilation. Tidal volumes of 0.5 L and 1 L were evaluated with inspiratory times of 1 s and 2 s. RESULTS: The system that premixed NO proximal to the ventilator was the only one that maintained constant NO delivery regardless of ventilatory pattern. The other systems delivered variable NO concentration during pressure control ventilation and spontaneous breathing modes. Systems that injected a continuous flow of NO delivered peak NO concentrations greater than the calculated dose. These variations were not apparent when a slow-response chemiluminescence analyzer was used. CONCLUSIONS: NO delivery systems that inject NO at a constant rate, either continuously or during inspiration only, into the inspiratory limb of the ventilator circuit produce highly variable and unpredictable NO delivery when inspiratory flow is not constant. Such systems may deliver a very high NO concentration to the lungs, which is not accurately reflected by measurements performed with slow-response analyzers.

Effect of Body Repositioning after Venous Air Embolism: An Echocardiographic Study—Geissler HJ, Allen SJ, Mehlhorn U, Davis KL, Morris WP, Butler BD. Anesthesiology 1997;86(3):710.

BACKGROUND: Current therapy for massive venous air embolism (VAE) may include the use of the left lateral recumbent (LLR) position, although its effectiveness has been questioned. This study used transesophageal echocardiography to evaluate the effect of body repositioning on intracardiac air and acute cardiac dimension changes. METHODS: Eighteen anesthetized dogs in the supine position received a venous air injection of 2.5 mL/kg at a rate of 5 mL/s. After 1 min the dogs were repositioned into either the LLR, LLR 10° head down (LLR-10°), right lateral recumbence, or remained in the supine position. RESULTS: Repositioning after VAE resulted in relocation of intracardiac air to nondependent areas of the right heart. Peak right ventricular (RV) diameter increase and mean arterial pressure decrease were greater in the repositioned animals compared with those in the supine position ($p < 0.05$). Right ven-

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tricular diameter and mean arterial pressure showed an inverse correlation ($r = 0.81$). Peak left atrial diameter decrease was greater in the LLR and LLR-10° positions compared with the supine position ($p < 0.05$). Repositioning did not influence peak pulmonary artery pressure increase, and no correlation was found between RV diameter and pulmonary artery pressure. All animals showed electrocardiogram and echocardiographic changes reconcilable with myocardial ischemia. CONCLUSIONS: In dogs, body repositioning after VAE provided no benefit in hemodynamic performance or cardiac dimension changes, although relocation of intracardiac air was demonstrated. Right ventricular air did not appear to result in significant RV outflow obstruction, as pulmonary artery pressure increased uniformly in all groups and was not influenced by the relocation of intracardiac air. The combination of increased RV afterload and arterial hypotension, possibly with subsequent RV ischemia rather than RV outflow obstruction by an airlock appeared to be the primary mechanism for cardiac dysfunction after VAE.

Prolonged "Phantom" Square Wave Capnograph Tracing after Patient Disconnection or Extubation: Potential Hazard Associated with the Siemens Servo 900c Ventilator—Ginosar Y, Baranov D. Anesthesiology 1997;86(3):729.

BACKGROUND: The authors report on the appearance of misleading square wave "phantom" capnograph tracings for approximately 3 min after disconnection from the Siemens Servo 900c ventilator. A series of experiments are described to examine the mechanism of this phenomenon. METHODS: Patients were ventilated using the Siemens Servo 900c ventilator with the following settings: minute volume, 5 L/min; respiratory rate, 8 breaths/min; PEEP, 0 cm H_2O; trigger sensitivity, 20 cm H_2O. The ventilator was connected to the Siemens Servo Evac 180 evacuation system (25 L/min on evacuation flowmeter). Airway pressure and capnography were recorded at the Y piece during ventilation and after disconnection. A back-up ventilator was used to support the patient during disconnection of the ventilator being studied. RESULTS: Initially, the "phantom" capnograph tracing closely resembled the square wave capnograph tracing before disconnection, but the amplitude and shape of the waveform gradually decayed. Based on experiments described in this article, the authors show that the carbon dioxide for the "phantom" capnograph tracing comes from the gas exhaled by the patient in the last breaths before disconnection and which is present in both the expiratory tubing and in the evacuation system. The small pressure gradient between the exhaust reservoir and the atmosphere causes reverse flow of expired gas after disconnection, when both the nonreturn

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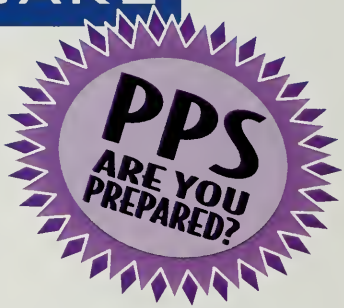

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flap valve at the exhaust outlet is open (due to minimal valve incompetence) and when the expiratory servo valve is open (in the absence of positive end-expiratory pressure). This continuous reverse flow is detected by the capnograph but is interrupted intermittently by each attempted positive pressure ventilation, thereby creating a "phantom" capnograph. CONCLUSIONS: After accidental disconnection of the patient from the breathing system, or after accidental extubation of the trachea, the "phantom" capnograph is likely to confuse even an experienced anesthesiologist into the mistaken belief that his rapidly deteriorating patient is being ventilated adequately. Several potential mechanisms to eliminate this phenomenon are outlined, including the avoidance of zero positive end-expiratory pressure. "Phantom" capnography provides an illustration of the dangers of using monitoring techniques, however reliable, as a substitute for vigilant clinical observation.

Feasibility of Noninvasive Mechanical Ventilation in the Treatment of Acute Respiratory Failure in Postoperative Cancer Patients—Varon J, Walsh GL, Fromm RE Jr. J Crit Care 1998;13(2):55.

PURPOSE: Patients with cancer who require mechanical ventilation have high mortality rates. Although oncological patients have multiple clinical problems, including nutritional and immunological deficiencies, added complications from mechanical ventilation by themselves may be life-threatening and may further compromise the ability of these patients to recover from an episode of acute respiratory failure (ARF). Noninvasive mechanical ventilatory support (NIMV) using positive pressure ventilation delivered through a mask has gained popularity for the treatment of ARF and may limit some mechanical ventilation complications. The purpose of this study was to prospectively evaluate NIMV in cancer patients with ARF. MATERIALS & METHODS: All patients admitted to the surgical intensive care unit (SICU) at The University of Texas MD Anderson Cancer Center from August 1, 1994, to April 15, 1996, with hypoxemic or hypercapnic ARF were eligible for this study. NIVM was delivered with the BiPAP S/T-D (Respironics, Murrysville PA) device. The initial settings were adjusted to achieve a tidal volume of 5 to 7 mL/kg and a S_{aO_2} greater than 0.90. Demographic data, duration of therapy, and need for endotracheal intubation were recorded for each patient. RESULTS: Sixty patients were included in this study. There were 21 women (35%) and 39 men. The primary cancer sites of these patients were gastrointestinal (25 patients), genitourinary (15), hematological (8), lung (6), sarcoma (4), and skin (2). Fifty-three patients (88%) had hypoxemic ARF and 7 had hypercapnic ARF. The mean duration of NIMV was 1.83 days (range, 1 to 5 days) with a median of 2 days. Forty-two patients (70%) were weaned from NIMV and were spared endotracheal intubation. The remaining 18 patients deteriorated and ultimately required intubation and assisted mechanical ventilation. No complications related to the use of NIMV were seen in this study population. CONCLUSIONS: NIMV was effective in the treatment of ARF in cancer patients at our institution substantially decreasing the need for intubation. This ventilatory technique is a viable option for cancer patients with ARF.

Pulmonary Stress Injury within Physiological Ranges of Airway and Vascular Pressures—Guery BP, DeBoisblanc BP, Fialdes P, Sarphy TG, Nelson S, Chidiac C, et al. J Crit Care 1998;13(2):58.

PURPOSE: The aim of this study was to assess the respective role of a small elevation in pulmonary capillary pressure, airway pressure, or both on alveolar capillary barrier permeability in an isolated perfused rat lung model. MATERIALS & METHODS: Four groups were studied with low or high airway pressure (LA: 10 mL/kg (tidal volume); HA: 20 mL/kg), low or high pulmonary artery pressure (LP: 9 mm Hg; HP: 12 mm Hg): LALP, HALP, LAHP, and HAHP. The lungs were ventilated and perfused

ex vivo for 30 minutes. Quantification of fluorescein isothiocyanate-labeled (FITC) dextran in bronchoalveolar lavage (BAL) fluid and radiolabeled tracers assessed alveolar capillary barrier permeability. RESULTS: BALF FITC-dextran was similar in the 3 groups with either 1 or 2 low-pressure parameters (LALP, LAHP, HALP), but high amounts were found in the HAHP group (375.2×10^{-6} mg/mL v, respectively, 21.4, 26.2, and 30×10^{-6} mg/mL, $p = 0.0001$). These results were consistent with the albumin space and extravascular lung water: higher values only in the HAHP group statistically different from the other groups ($p < 0.002$). Interalveolar pore examined with scanning electron microscopy showed an increase in diameters between LALP and HAHP ($p < 0.0001$). CONCLUSIONS: We can conclude that elevation of either the pulmonary artery pressure from 8 to 11 mm Hg or the alveolar pressure from 10 to 15 mm Hg alone does not change the permeability of the alveolar capillary membrane; however, there is an additive effect of these pressures.

A Comparison of Mini-Bronchoalveolar Lavage and Blind-Protected Specimen Brush Sampling in Ventilated Patients with Suspected Pneumonia—Marik PE, Careau P. J Crit Care 1998;13(2):67.

PURPOSE: Mini-bronchoalveolar lavage (m-BAL) and blind-protected brush sampling (b-PSB) are minimally invasive methods of diagnosing pneumonia in mechanically ventilated patients. The aim of this study was to compare these techniques in a prospective study at a medical and surgical intensive care unit in a university-affiliated community teaching hospital. PATIENTS & METHODS: One hundred and ninety episodes of pneumonia were suspected in 175 mechanically ventilated patients. Sequential b-PSB followed by m-BAL were performed by respiratory therapists who had undergone specialized training. A b-PSB quantitative culture greater than 1,000 cfu/mL and a m-BAL $>10^4$ cfu/mL was considered diagnostic of pneumonia. Colony counts between 500 and 1,000 cfu/mL and 5,000–10^4 cfu/mL, respectively, were considered borderline positive. RESULTS: One hundred and ninety paired specimens were obtained from 175 patients. The diagnostic agreement between the two techniques was 90%. Sixty-six patients (37%) were considered to have bacterial pneumonia. In 108 episodes, patients were receiving concurrent antibiotics; pneumonia was diagnosed in 30 (27%) of these cases compared with 36 of 82 (43%) episodes of antibiotics ($p = 0.03$). In 6 episodes, m-BAL was negative and b-PSB was positive (1 patient receiving antibiotics). In 13 episodes, b-PSB was negative and m-BAL was positive (7 patients were receiving antibiotics). The b-PSB took 30 ± 8 seconds to perform and was complicated by minor bleeding in 3 cases. The m-BAL took 5 ± 2 minutes to perform, was considered easy in 105 cases, difficult/very difficult in 63, and failed in 2 patients. Significant coughing occurred in 98 patients with other minor reversible complications occurring in a further 20 cases. CONCLUSIONS: In mechanically ventilated patients with suspected pneumonia both b-PSB and m-BAL can be performed safely by respiratory therapists. The tests complement each other and likely reduce the number of false-negative results.

Clinical Evaluation of the Abbott Qvue-OptiQ Continuous Cardiac Output System in Critically Ill Medical Patients—Monchi M, Thebert D, Cariou A, Bellenfant F, Joly LM, Brunet F, Dhainaut JF. J Crit Care 1998;13(2):91.

PURPOSE: The aim of this study was to evaluate the reliability of a new continuous cardiac output (CCO) monitoring device (Qvue/OptiQ system; Abbott Critical Care Systems, Mountain View CA) based on the pulsed warm-thermodilution technique in critically ill medical patients. METHODS: Nineteen patients with cardiogenic or septic shock were included in the study. Pairs of CCO and intermittent bolus

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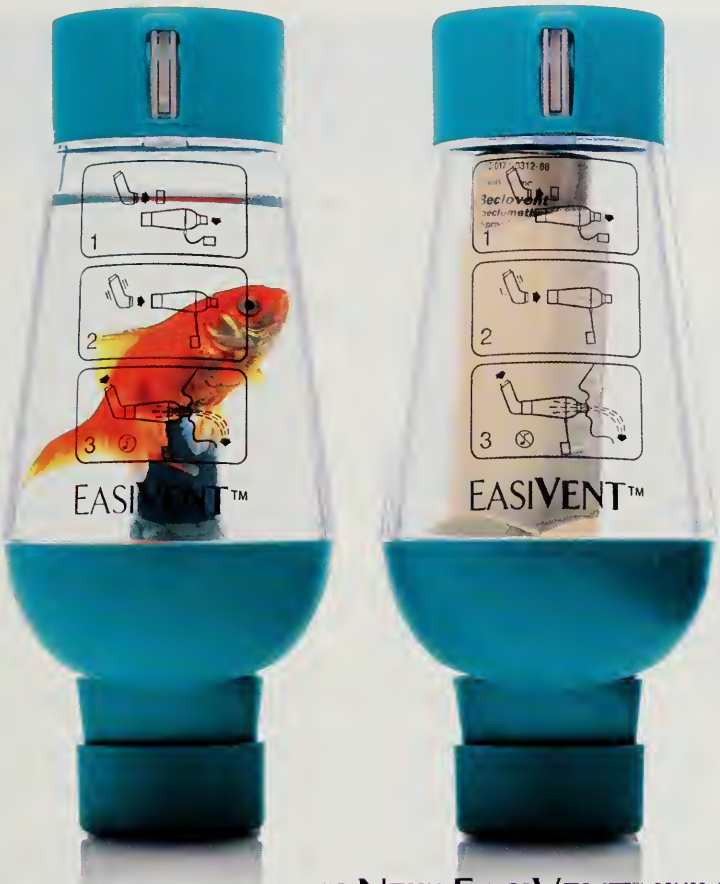

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cardiac output (ICO) were noted at least every 6 hours for determination of bias, precision, and limits of agreement. Simultaneously, blood samples were collected, and arterial-venous oxygen content difference ($C[a-v]O_2$) was determined. A multiple stepwise logistic regression was used to identify situations associated with a CCO-ICO difference exceeded 20%. A multiple linear regression was performed to analyze the respective accuracy of CCO and ICO to predict the variations of ($C[a-v]O_2$). RESULTS: A total of 203 pairs of cardiac output measurements was obtained. The bias was 0.12 L/min (1.2% of pairs mean) and the precision 1.0 L/min (13%). The 95% limits of agreement were between −1.7 L/min (−25%) and 1.9 L/min (+26%). Low blood temperatures and heart rates above 120 beats/min were significantly associated with a ICO-CCO difference higher than 20%. In a multiple linear regression, CCO was significantly correlated with ($C[a-v]O_2$), an independent reflection of the patient's cardiac output; by contrast, ICO did not. CONCLUSION: These results suggest that ICO and CCO measurement by the Qvue/OptiQ system are interchangeable, except for temperature or heart rate extreme values.

Regional Deposition of Inhaled Particles in Human Lungs: Comparison between Men and Women—Kim CS, Hu SC. J Appl Physiol 1998;84(6):1834.

We measured detailed regional deposition patterns of inhaled particles in healthy adult male (n = 11; 25 ± 4 y of age) and female (n = 11; 25 ± 3 y of age) subjects by means of a serial bolus aerosol delivery technique for monodisperse fine [particle diameter (Dp) = 1 &mgr;m] and coarse aerosols (Dp = 3 and 5 &mgr;m). The bolus aerosol (40 mL half-width) was delivered to a specific volumetric depth (V_p) of the lung ranging from 100 to 500 mL with a 50-mL increment, and local deposition fraction (LDF) was assessed for each of the 10 local volumetric regions. In all subjects, the deposition distribution pattern was very uneven with respect to V_p, showing characteristic unimodal curves with respect to particle size and flow rate. However, the unevenness was more pronounced in women. LDF tended to be greater in all regions of the lung in women than in men for Dp = 1 &mgr;m. For Dp = 3 and 5 &mgr;m, LDF showed a marked enhancement in the shallow region of $V_p \leq 200$ mL in women compared with men ($p < 0.05$). LDF in women was comparable to or smaller than those of men in deep lung regions of $V_p > 200$ mL. Total lung deposition was comparable between men and women for fine particles but was consistently greater in women than men for coarse particles regardless of flow rates used; the difference ranged from 9 to 31% and was greater with higher flow rates ($p < 0.05$). The results indicate that (1) particle deposition characteristics differ between healthy men and women under controlled breathing conditions and (2) deposition in women is greater than that in men.

Strategies and Methods for Aligning Current and Best Medical Practices: The Role of Information Technologies—Schneider EC, Eisenberg JM. West J Med 1998;168(5):311.

Rapid change in American medicine requires that physicians adjust established behaviors and acquire new skills. In this article, we address 3 questions: What do we know about how to change physicians' practices? How can physicians take advantage of new and evolving information technologies that are likely to have an impact on the future practice of medicine? and What strategic educational interventions will best enable physicians to show competencies in information management and readiness to change practice? We outline 4 guiding principles for incorporating information systems tools into both medical education and practice, and we make 8 recommendations for the development of a new medical school curriculum. This curriculum will produce a future medical practitioner who is capable of using information technologies to systematically measure practice performance, appropriateness, and effectiveness while updating knowledge efficiently.

Outcomes Research: Starting To Make Its Mark in Defining Optimal Respiratory Care Practices

The outcomes movement has been dubbed "the third revolution in medical care."[1] It represents an era of unprecedented activity directed at the assessment of clinical outcomes, the analysis of medical effectiveness, and efforts aimed at quality assurance or improvement.[2] The potential importance of outcomes research to the fields of pulmonary and critical care medicine has recently been reviewed, to include a proposed curriculum for the training of outcomes researchers in these fields.[3] Outcomes research represents a specific area of clinical research that has gained attention and popularity due to its focus on the outcomes associated with variations in medical care practices.[4,5] Outcomes research usually examines the efficacy of medical and surgical treatments in 'real' clinical settings and not in the more controlled settings of highly structured clinical trials. Therefore, much of the research performed by outcomes researchers is observational.[6–9] Although the exact definition of outcomes research may be debated, it is broad enough to include large, population-based randomized controlled studies evaluating the effectiveness of a specific treatment in the clinical setting.[10]

See the Study on Page 637

Several factors have resulted in the current emphasis on clinical outcomes and the assessment of medical effectiveness. First, there is a need for medical care cost containment due to the increases in medical care spending that have occurred over the past three decades. Outcomes research is seen as a means of ensuring that managed care systems, designed to control the increase in medical services, do not result in deleterious effects on the quality of care.[2] Second, there is increasing competitiveness in the health care industry. Health maintenance organizations compete to attract increasing market shares to their organizations. This competition often results in cost cutting, in order to provide medical services at lower prices, which is often viewed as the best mechanism for attracting new customers. However, the quality of medical care may also suffer as a result of cost cutting; quality of care should be considered by any organization deciding to purchase health care for its employees or beneficiaries. Third is the available work of leading researchers in the outcomes movement demonstrating substantial geographic variation in the use of surgical procedures and the delivery of medical care.[8,11,12] This groundbreaking research has led to similar types of investigations in other clinical areas to include pulmonary and critical care medicine.[13,14]

Outcomes research, along with its methodologies and core curriculum,[3] should be viewed as an important discipline for the field of respiratory care. In large part, this is due to the ability of outcomes research to help define the clinical benefits of respiratory care services and to identify the 'best' respiratory care practices based on regional variations. Other medical care specialties have recognized the potential benefits associated with the performance of outcomes research.[15–17] Specific clinical areas where outcomes research techniques could be successfully employed in the field of respiratory care include: (1) determining the effectiveness of quality improvement initiatives aimed at improving patient outcomes, reducing medical care costs, or simultaneously accomplishing both goals; (2) comparing variations in respiratory care practices in order to determine the most cost-effective practices for general implementation; (3) developing and assessing innovative practice changes in the field of respiratory care; and (4) evaluating the appropriateness of resource utilization in clinical areas employing respiratory care clinicians compared to similar clinical settings without such clinicians.[18]

In this issue of Respiratory Care, Stoller and colleagues report their experience at the Cleveland Clinic Hospital using a Respiratory Therapy Consult Service (RTCS) for the delivery of respiratory care.[19] They compared baseline data from 1991, prior to establishment of the RTCS in 1992, to clinical data obtained from 1996. The total utilization of four of the five highest volume respiratory care therapies (aerosols, oxygen therapy, incentive spirometry, bronchopulmonary hygiene) decreased in 1996 compared to 1991, while the use of metered dose inhalers increased during this same time period. These reductions were associated with a cost savings of 29%, representing almost a half million dollars for this institution. Patient outcomes as measured by hospital mortality, hospital readmissions, and the average hospital length of stay were not affected by institution of the RTCS. Although this investigation's results are limited by the before-after study design employed and the absence of a direct severity of illness comparison between the two study groups, the study provides impor-

tant preliminary data in support of using a RTCS for the provision of non-intensive care unit (non-ICU) respiratory therapy. This study qualifies as outcomes research due to its evaluation of clinical outcomes in a 'real world' setting during variations in respiratory therapy practices.

Based on the study by Stoller and coworkers,[19] how should individual institutions proceed in terms of evaluating their own respiratory therapy practices and the need for a RTCS? First, it should be recognized that each medical institution has inherent properties that will facilitate or hinder implementation of a RTCS, like the one used at the Cleveland Clinic. Variables such as the severity of illness of hospitalized non-ICU patients, the preferences of the attending physicians, reimbursement methods for physician and non-physician services, and the culture of the hospital, to include support from the administration and the medical director of respiratory therapy, will all influence whether and how changes in respiratory care practices occur. Second, it is important to note that changes in respiratory care practices can still take place on a smaller scale even if implementing a RTCS is perceived as an unrealistic achievement. For example, a respiratory therapy department may wish to change one specific practice, based on the quality of the available medical evidence, and evaluate the impact of that practice change using an outcomes approach (ie, evaluating clinical outcomes, cost-effectiveness, and quality of care variables).[20] Such small-scale changes, if successfully undertaken, can be extremely valuable in winning support and enthusiasm from the hospital administration, the medical staff, and the respiratory therapists themselves for the performance and evaluation of future practice changes. Improvement models such as Plan-Do-Study-Act (PDSA) cycles can be employed to test such changes in a local setting of care.[20,21]

The process of evaluating and implementing useful changes at the local level could lay the foundation for further practice changes potentially resulting in the development of a RTCS. We have undertaken such an approach at Barnes-Jewish Hospital. Over a period of approximately five years our respiratory therapy department has been involved in the evaluation of a number of clinical practice changes. These practice changes were initially based on the available medical literature, input from national and local experts, and the recommendations of national medical organizations. Several examples of practice changes undertaken by our respiratory therapy department, and some of their supporting literature, include having respiratory therapists participate in the weaning of mechanical ventilation,[22,23] the substitution of metered dose inhalers for aerosols,[24,25] and improved criteria for the use of chest physiotherapy.[26–29] These practice changes have resulted in the development of a Respiratory Care Reference Guideline at Barnes-Jewish Hospital that is used by respiratory care clinicians to guide their patient evaluations. Additionally, based in large part upon this prior experience, we are currently undertaking a prospective evaluation of a RTCS at Barnes-Jewish Hospital sponsored by the American Association for Respiratory Care.

Respiratory care providers have historically functioned as an integral component of the health care team caring for hospitalized patients. However, economic forces have resulted in a reexamination of the need for respiratory care clinicians in some clinical settings.[30,31] Outcomes research should be grasped by the respiratory therapy profession as a means of documenting the importance of its role in both the inpatient and outpatient settings. This includes demonstrating the impact of this care on clinical outcomes as well as medical care costs. Additionally, respiratory therapy professionals are in a unique position to identify variations in clinical practices, and their influence on outcomes, based on regional or geographic preferences. Future efforts should be aimed at performing outcomes investigations in the field of respiratory care. The challenge will be to find the resources and the individuals willing to undertake such studies.

Marin H Kollef MD FCCP
Associate Professor of Medicine
Department of Internal Medicine
Pulmonary and Critical Care Division
Washington University School of Medicine
Director, Medical Intensive Care Unit
Director, Respiratory Care Services
Barnes-Jewish Hospital
St Louis, Missouri

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Correspondence: Marin H Kollef MD FCCP, Pulmonary and Critical Care Division, Campus Box 8052, 660 South Euclid Avenue, St. Louis MO 63110, e-mail: mkollef@pulmonary.wustl.edu.

The Clinician Meets the Outcomes Researcher

In this issue of Respiratory Care is a position paper by John Salyer,[1] "Continuous Pulse Oximetry and Patient Outcomes: A Skeptical View," in which the author directs criticism at the practice of continuous monitoring with pulse oximetry. His arguments are strong in that little or no research attention has been paid to the impact on patient outcome produced by continuously monitoring oxygen saturation. While much information exists on the accuracy of data, the conditions that affect the signal quality, and the cost of using pulse oximetry, scant information exists regarding when it might be useful to employ this monitor. The universal application of the monitor [at least in the operating room (OR)] makes an ethical, prospective trial comparing monitoring with not monitoring almost impossible to perform. This widespread adoption of continuous monitoring with pulse oximetry in the OR despite the lack of outcome research proof of effectiveness is not surprising but needs to be understood. Understanding why pulse oximetry is used and has become a standard of care in the OR environment may lead to ways to evaluate monitors in general. The purpose of this discussion is to develop an appreciation of the difficulties in evaluating the impact of monitoring on outcome.

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My view of how to approach evaluation of monitors makes me oppose the negative position taken by the author of the Points-of-View article. 'To monitor' means 'to *observe* closely,' a 'monitor' is an 'advisor, informant, or counselor.' Monitors are not active devices; they do not directly provide patient care. They can only advise or inform. In evaluating the effect of monitors on patient care, it is important to remember this fact. The actual monitor is only a small part of the system that may result in initiation of action. The clinician selecting and using the monitor is the essential component in a system which may alter patient outcome. The impact of using a monitor cannot be assessed without considering the user of the monitor. It is the clinician who makes decisions and takes actions that alter patient outcome, not the monitor itself. Errors in using the data produced by monitors may result in an undesired patient outcome despite appropriate monitor selection and function.

Monitoring outputs are sometimes confused with diagnostic tests and used as such. This is true of pulse oximetry when 'pulse ox checks' are used to diagnose hypoxemia in place of determining P_{aO_2} using intermittent arterial blood gas analyses. This overlap between *diagnosis* and *monitoring* further confuses the issues of the evaluation of monitoring. If the device is only used intermittently, then diagnosis rather than monitoring is being performed. If a clinician attaches a monitor and then leaves the patient, no positive impact on patient outcome is likely.

When a particular event is believed to cause an undesired or lethal outcome, action should be empirical without delaying to more firmly establish the cause (diagnosis). Alarms are a special case of monitoring related to this situation. When the parameter being monitored falls outside of the safe range, a visual or auditory 'alarm' is issued by the monitoring device. Once again, no change in patient treatment is performed by the monitoring device, a decision to act must be taken by a caregiver. Caregivers often have control over the limits that trigger the monitor alarm. They may disable the alarm sounds and not respond to the alarm. Given the total care system, it is not reasonable to expect that monitors by themselves will impact patient care in a positive way. Any time a monitor is evaluated for its impact on patient care, this complicated action scheme must be taken into account. The caregiver using the device has the major (only) impact on outcome.

Often several monitors reflecting different, but related, aspects of patient physiology are used concurrently. It is often difficult to identify the most important monitor in a given situation. An experienced, watchful clinician can often respond appropriately to a critical situation without use of complicated monitors. These individuals are able to integrate monitor data and form appropriate action plans. Inexperienced caregivers may inappropriately respond to monitor data and treat the monitor, not the patient. This further confuses the objective analysis of the impact of specific monitors on patient care.

Besides aiding the caregiver in making active interventions, monitors can reduce anxiety in caregivers by confirming that the functions being monitored are going well. This allows attention to be directed to other areas or other patients. Monitors are extensions of the caregiver's senses. More than one variable can be watched simultaneously. In a busy intensive care unit, unlike the usual OR, one caregiver is often managing two or more patients. Monitors can help accomplish this difficult task efficiently. Fair outcome evaluation of monitors must take this gain in efficiency into account as well as the impact on a single patient.

Anesthesiologists feel that monitoring with pulse oximetry is essential during anesthesia. It is believed that detection of hypoxia before organ compromise occurs is facilitated by pulse oximetry. In his criticism John Salyer cites a study by Moller and colleagues[2] and concludes that in 20,800 patients randomized to receive or not receive pulse oximetry monitoring during anesthesia there was no difference in "cardiovascular, respiratory, neurologic, or infectious events between those with and without oximetric monitoring." However, there were more "subtle changes in the patients' electrocardiograms" seen in patients not receiving pulse oximetry monitoring. These included significant electrocardiographic ST wave segment depression associated with tachycardia, increased frequency of ventricular premature contractions, sinus arrest, Mobitz type-II block, and ventricular tachycardia (nonsustained). Yes, there were no "permanent" complications, however, the purpose of the study was to identify possible markers of poor outcome.

The clinical detection of hypoxemia (cyanosis) is difficult and inexact, especially during general anesthesia. Because irreversible harm from hypoxemia occurs rapidly, and laboratory evaluation of arterial oxygenation is invasive, delayed, and expensive, oximetry, with its many faults, has been accepted as an advance in monitoring for hypoxemia by those practicing in the OR environment. Reduction in malpractice premiums is a positive outcome directly attributable to adoption of pulse oximetry in the OR. In Moller et al's paper, a further point clearly articulated was that even when presented with the study's negative results, the anesthesiologists in his hospital still insisted on using pulse oximetry. It must have had significant value to these caregivers.

An approach to the analysis of the utility of monitoring technology is offered by Inman and associates.[3] They define levels of use requiring different levels of proof. The following definitions are useful in this process of evaluation.

Clinical utility is the ability of a device or treatment to achieve its ascribed goals under controlled circumstances. For example, monitoring devices have been evaluated for clinical utility. Evaluation of a monitor includes demonstration of accuracy and correlation with other known effective monitors. It also includes demonstrating that the monitor contributes to a desired outcome with a known disease process in prospective, controlled studies performed in carefully selected clinical situations. Some physiological monitors have been tested in this way and demonstrate accuracy, predictability, and correlation with expected outcome.

Clinical effectiveness, on the other hand, is the ability of the device or treatment to achieve the same desired results under less rigorously controlled use. In general, this level of proof has not been demonstrated with any monitor and for few clinical treatments. It has been estimated that only 20% of all currently accepted forms of treatment have been proven clinically effective. I believe it is unreasonable to demand this level of proof for a monitoring device.

For monitoring devices and equipment a middle ground may be clinical usefulness (my term). This concept reflects the balance between accuracy, ease of use, and production of meaningful information. A device will only be used

1. if its use is mandated by policy,
2. if it is felt to be 'worth the trouble' by the user (if given a choice), or
3. if both mandated and useful.

To demonstrate the clinical usefulness of a monitor, caregivers must be given the choice of using it or not, with the majority choosing to use it. This would satisfy the condition set forth in Number 2 and could serve as a way of evaluating technology in general.

Cost-effectiveness of a treatment or device, in addition to being clinically effective (or at least useful), implies it costs less or incurs less risk than other accepted treatments currently in use. New technology and treatments should not be introduced unless they are: (1) less costly and at least as effective as the current standard; (2) more costly but more effective and the added benefit is worth the added cost; or (3) less effective and less costly but the benefit of the current standard treatment or device is not worth the added cost. With these ideas in mind, including the concept of clinical usefulness, pulse oximetry outside the OR should be evaluated.

Charles G Durbin Jr MD FCCM
Professor of Anesthesiology
University of Virginia
Charlottesville, Virginia

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Correspondence: Charles G Durbin Jr MD, Department of Anesthesiology, UVA Health Science Center, PO Box 10010, Charlottesville VA 22906-0010, e-mail: cgd8v@virginia.edu.

The Invasion of Noninvasive Ventilation: Changing Demographics of Long-Term Mechanical Ventilation

Clinicians caring for chronically ventilator-assisted individuals (VAI) (those receiving at least 6 hours of assistance daily for 30 or more days) are well aware that major changes have occurred over the past dozen years. Sites of care have been changing, with acute care facilities establishing on-site ventilator units and subacute and chronic care facilities opening weaning units, many of them for-profit. In addition, noninvasive positive pressure ventilation (NPPV) is being increasingly used, greatly simplifying the care of VAIs. Although these trends are obvious to workers in the field, the decentralized and complex payer structure in the U.S. has precluded any nationwide tracking mechanism from documenting them. The study by Adams et al[1] in this issue of RESPIRATORY CARE is helpful in this regard. By using similar methods at each time point over an 11-year period, the study provides serial 'snapshots' of VAI demographics during three different years—1986, 1992, and 1997.

The serial surveys document a steady increase in the number of VAIs, now estimated at approximately 17,000 nationwide. This compares to estimates of 6,000 in 1983,[2] 10,000 in 1990,[3] 11,000 in 1991,[4] and 12,000 in 1992,[5] based on extrapolations from previous surveys. In the 1997 Minnesota survey, the largest category of long-term ventilator users remained those with ventilatory muscle dysfunction, although there are some interesting trends within this group. As might be expected, post-polio patients are becoming less numerous as this group ages and succumbs to attrition. On the other hand, the substantial drop in VAIs with amyotrophic lateral sclerosis (ALS) is unexpected and unexplained. In the absence of a decline in the incidence of ALS, this may indicate a reduction in the use of long-term mechanical ventilation by ALS patients, particularly by invasive methods.

The study also documents the increase in the number of dedicated VAI care units as well as agencies providing VAI care. There are also substantial increases in use among the pediatric age groups and the elderly. Although the pediatric users are not well characterized, the increase is apparently related to noninvasive applications among children with sleep disorders and congenital abnormalities, many of whom apparently have central hypoventilation. The increase in the elderly age group appears to be attributable to COPD patients, a substantial proportion of whom are using noninvasive ventilation. Indications for noninvasive ventilation in COPD patients are not well defined, but this increase is most likely reflective of national trends.

The most remarkable demographic change detected by the survey is that relating to use of noninvasive ventilation, which is responsible for almost half of the increase in VAIs between the 1992 and 1997 surveys. This increase is almost entirely ascribable to NPPV; the number of patients using other noninvasive ventilators has remained essentially unchanged. Although noninvasive ventilation still comprises only 17% of the total number of VAIs in the 1997 survey, the substantial increase in the number of VAIs using NPPV is reflective of the national consensus that NPPV is the preferred ventilatory modality for hypoventilating patients with restrictive thoracic disorders who require mainly nocturnal assistance and have adequate upper airway function.[6] Considering the cost and convenience advantages of NPPV over invasive ventilatory modes for the delivery of long-term mechanical ventilation, this is a welcome trend that should continue.

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The survey methods used in Adams et al's study are subject to numerous limitations. Lacking any independent test of validity, the results are entirely dependent on the accuracy of respondents. This is of particular concern with regard to diagnosis. Also, the results provide only indications of the prevalence of ventilator use at three different points in time; individual patients were not tracked serially to determine outcomes. In addition, there are undoubtedly missing data. The authors did not survey for NPPV in 1992, although reports from other institutions in Minnesota at the time indicate that NPPV was in use.[7] Further, the authors surveyed only for users of NPPV with a backup rate, excluding those patients who may be using pressure-limited portable ventilators without a backup rate, hence introducing a bias toward underestimation of the total number of NPPV users. Thus, the data must be interpreted and generalized only with great caution.

Nonetheless, in the absence of a national database, serial surveys such as this are valuable in confirming our impressions about trends in long-term mechanical ventilation. From studies like this, we can deduce that the use

of long-term mechanical ventilation has increased in prevalence, outstripping increases in the general population. We know that chronic care facility beds as well as health care agencies devoted to the care of long-term ventilator users have increased, keeping pace with the number of VAIs living at home. The increase in the use of NPPV is another very important trend detected by the study. However, studies such as these leave many important questions unanswered. There is no way to determine whether reimbursement policies or services provided to VAIs are adequate. There is no way to assess the appropriateness of ventilator applications, such as use of NPPV for chronic obstructive pulmonary disease patients, and no way to assess costs. We should view such surveys as blunt instruments that shed light on what we are doing, but cannot tell us how well we are doing it. Studies such as this one should stimulate additional investigation to address these more difficult questions.

Nicholas S Hill MD
Director, Critical Care Medicine
Rhode Island Hospital
Providence, Rhode Island

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Correspondence: Nicholas S Hill MD, Rhode Island Hospital, APC Bldg, Room 475, 593 Eddy Street, Providence RI 02903-4923, e-mail: nicholas_hill@brown.edu.

Changing Patterns of Respiratory Care Service Use in the Era of Respiratory Care Protocols: An Observational Study

James K Stoller MD, Douglas Orens RRT MBA, and Muzaffar Ahmad MD

BACKGROUND: As part of our ongoing analysis of respiratory care services at the Cleveland Clinic Foundation (CCF), we reviewed the differences in volume and costs of providing respiratory care services over a six-year period, comparing a time period before our respiratory care protocol service was available (1991) to a time after this service was widely used (1996). METHODS: The Respiratory Therapy Consult Service (RTCS) was first implemented hospitalwide for use at physician discretion in February 1992 and was mandated for most nonintensive care unit (non-ICU) adult inpatient care in August 1994. Using true variable and fixed costs for providing respiratory care services and a management information system that tallies all respiratory care services delivered, we calculated the volume and cost associated with the five highest-volume adult non-ICU respiratory care services at the Cleveland Clinic Hospital: aerosol medication delivery (SVN), metered dose inhalers (MDI), oxygen therapy, bronchopulmonary hygiene (BPH), and incentive spirometry. To assess the impact of the RTCS on volume and costs of respiratory care services, 1991 data were compared with 1996 data. RESULTS: Despite a stable hospital census between 1991 (16,989 patients) and 1996 (16,556 patients), the total number of these five therapies administered decreased (202,728 in 1991 to 147,101 in 1996). The accompanying decrease in cost for these services was $460,666 over this interval. The mean cost per patient for providing the five therapies was reduced from $94 in 1991 to $69 in 1996. Most of the savings were associated with a decline in the volume of time-consuming services (ie, SVN and BPH) by 46,623 treatments, producing a cost decrease of $368,339. Delivery of aerosolized bronchodilators (SVN, MDI) decreased by 16,673 treatments, coupled with an 11% increase in the proportion of bronchodilator therapies administered by MDIs (less costly than SVNs), which rose from 25% of all bronchodilators (22,513) in 1991 to 36% (26,371) in 1996. This 11% increase in MDI treatments along with the total reduction in bronchodilator treatments administered resulted in a cost savings of $153,824. Oxygen therapy was reduced by 9,751 patient-days over the six-year period, resulting in cost savings of $9,556. CONCLUSIONS: We conclude that between 1991 and 1996, changing patterns of use for the highest-volume respiratory care services delivered to non-ICU adult inpatients were associated with a substantial decrease in the number of therapies and associated costs and that implementation of the RTCS during this interval was associated with a cost savings, though this temporal correlation does not establish causality, ie, that the RTCS caused this savings. On the other hand, the lack of a tenable alternative explanation for this trend strengthens our belief that use of the RTCS is, at least, a contributing factor. [Respir Care 1998;43(8):637–642] *Key words: Respiratory therapy consult services, protocols, cost effectiveness.*

Background

Because misallocation of respiratory care services (consisting of both 'over-ordering' and 'under-ordering') occurs commonly,[1–4] we have implemented a respiratory care protocol service at the Cleveland Clinic [called the Respiratory Therapy Consult Service (RTCS)] with the intent of improving allocation of these services.[5,6] The RTCS was begun in 1992 with a pilot program, was expanded thereafter, and as of August 1994, has been mandated for di-

James K Stoller MD, Head, Section of Respiratory Therapy; Douglas Orens RRT MBA, Manager, Section of Respiratory Therapy; and Muzaffar Ahmad MD, Chairman, Division of Medicine, from the Section of Respiratory Therapy, Department of Pulmonary and Critical Care Medicine, Division of Medicine, Cleveland Clinic Foundation, Cleveland, Ohio.

Reprints & Correspondence: James K Stoller MD, Cleveland Clinic Foundation, Department of Pulmonary and Critical Care Medicine, A 90, 9500 Euclid Avenue, Cleveland OH 44195.

recting the respiratory care of most adult non-intensive care unit inpatients at the Cleveland Clinic Hospital. Although several studies from our institution[6–8] and others[1,9–12] have demonstrated the effectiveness of respiratory care protocol programs in enhancing allocation of respiratory care services safely and with decreased costs of respiratory care services compared with physician-directed respiratory care, little attention has been given to the impact of such services on the overall volume and types of respiratory care services administered. To address this issue, the current study describes the changing pattern of respiratory care services administered at the Cleveland Clinic Hospital during the five-year period since implementing the RTCS. We compare the recent pattern of respiratory care services to that before the inception of the RTCS, when respiratory care was administered in a traditional, physician-directed model. We hypothesized that use of the RTCS would decrease over-ordering of respiratory care services and, by enhancing allocation in this way, would decrease the volume of respiratory care services delivered.

Methods

Before launching the RTCS, patterns of utilizing respiratory care services reflected physicians' practices of ordering respiratory care. Then, respiratory care orders were placed by any of the approximately 450 staff physicians or 600 fellows and house staff in our institution, though most orders were placed by house officers with oversight by attending staff. With the availability of the RTCS in February 1992, physicians could elect to specify respiratory care orders themselves or request a Respiratory Therapy Consult. As of August 1994 when the RTCS was made mandatory for most adult non-intensive care unit (non-ICU) inpatients in our hospital, all orders for respiratory care services (other than for incentive spirometry only or short-term supplemental oxygen) trigger a Respiratory Therapy Consult, that generates a respiratory care plan and preempts prior orders. When physicians' modifications of the respiratory care plan were made, these changes were implemented. In addition, guided by each patient's changing clinical status and Triage Score[11] (a respiratory severity index), respiratory care plans were modified by the RTCS during shift meetings and after formal re-evaluation. The volume and time requirements for each of the respiratory care services considered were tracked using a management information system (CliniVision, Nellcor-Puritian-Bennett, Carlsbad CA). Also, the true direct and indirect costs of respiratory care services were tallied using TSI cost management software (Transitions Systems, Boston MA). These calculations account for the actual time-based cost of the services, including labor (with benefits), required equipment and supplies, medications, depreciation, and maintenance of equipment.

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For purposes of this analysis, the five highest-volume respiratory care services delivered to adult inpatients were considered, including aerosolized medications by small volume nebulizers (SVN), metered dose inhalers (MDI), supplemental oxygen therapy, bronchopulmonary hygiene (BPH), and incentive spirometry (IS). To assess the impact of the RTCS on the volume and cost of respiratory care services, we compared use of respiratory care services before the inception of the RTCS (1991) with current use, now that the RTCS supervises virtually all of the respiratory care given to eligible adult non-ICU inpatients.

Results

As shown in Figure 1, the total number of these five high-volume therapies administered in the Cleveland Clinic Hospital decreased by 28.4% between 1991 and 1996. Except for a brief rise in 1994, likely related to the addition of Kaiser-Permanente inpatient services to the Cleveland Clinic Hospital (Fig. 2), the number of adult non-ICU inpatients receiving respiratory care services was relatively flat (ie, 2.5% decrease over 5 years), even in the face of a 38% rise in total hospital admissions over the same interval (Fig. 3). Considering only those patients receiving respiratory care treatments, Figure 4 shows an 18% decline in the mean number of five high-volume therapies administered per patient over the interval 1991–1996 (from 11 to 9/patient). Further examination shows that the overall decrease in the volume of the five respiratory therapies was due to a decrease in all of the therapies except metered dose inhalers, which increased. Specifically, the number of therapies (for 1996 vs 1991) were: SVN (47,498 vs 68,029), oxygen therapy (40,316 vs 50,067), IS (19,018 vs. 22,199), BPH (13,898 vs 39,990), and MDI (26,371 vs 22,513).

The total cost of these five high-volume therapies for non-ICU adult inpatients decreased by 29% between 1991 and 1996 (from $1,596,550 to $1,138,443) (Fig. 5) with a commensurate decrease in the per patient cost of these high-volume therapies of 27% (from $94 to $69 per patient, Fig. 6).

Overall, the observed trends suggest a progressive decline in the total number of respiratory care services delivered, accompanied by a relatively stable number of patients receiving these respiratory care services and a

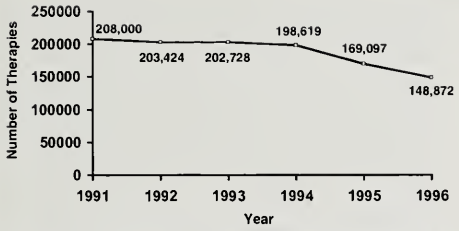

Fig. 1. The number of high-volume respiratory therapies administered to non-ICU adult inpatients between 1991 and 1996.

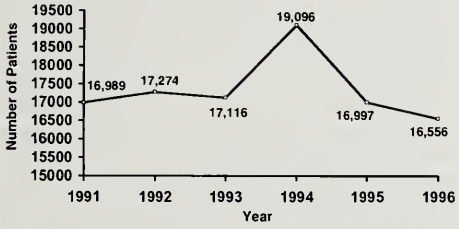

Fig. 2. The number of non-ICU adult inpatients receiving respiratory care services at The Cleveland Clinic Hospital between 1991 and 1996.

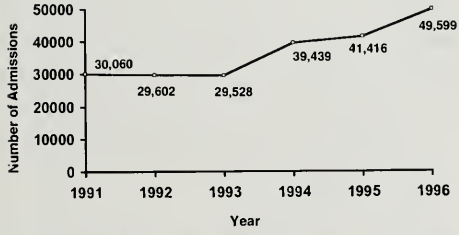

Fig. 3. The number of admissions to the Cleveland Clinic Hospital between 1991 and 1996.

resulting decline in the mean per capita use. Decreased per capita use was accompanied by a decreased cost per patient for the respiratory care services. These trends suggest decreased utilization of respiratory care services over the four-year interval from when the RTCS was first introduced (1992) to its full-blown implementation for non-ICU adult inpatient care at the Cleveland Clinic Foundation (1994–1996).

To examine the relationship between volume of services provided, use of the RTCS, and clinical outcomes, we compared outcomes in all patients with a primary diagnosis of chronic obstructive pulmonary disease (COPD) [di-

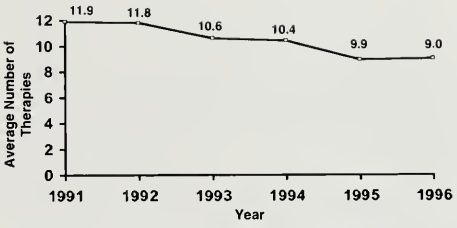

Fig. 4. The mean number of high-volume therapies per non-ICU adult inpatient in the Cleveland Clinic Hospital between 1991 and 1996.

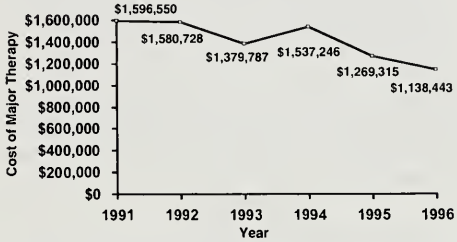

Fig. 5. The total cost of high-volume respiratory therapies administered to non-ICU adult inpatients at the Cleveland Clinic Hospital between 1991 and 1996.

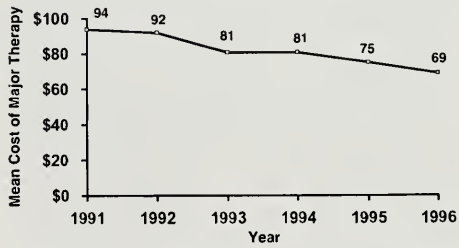

Fig. 6. The mean cost of high-volume respiratory care therapies per patient receiving at least one of the five therapies administered to non-ICU adult inpatients at the Cleveland Clinic Hospital between 1991 and 1996.

agnosis-related group (DRG) 088] admitted to the Cleveland Clinic Hospital between 1991 and 1996 (Fig. 7). It is notable that over this time interval when the volume of respiratory care therapies decreased, outcomes in COPD patients (who would be expected to be high consumers of respiratory care services) were stable or improved. Specifically, hospital mortality rate decreased from 4.4%

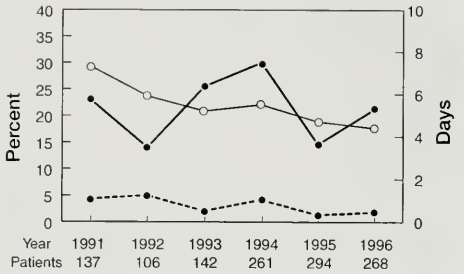

Fig. 7. Rates of hospital mortality and re-admission and mean hospital length of stay for patients with chronic obstructive pulmonary disease (Diagnosis-Related Group 088) admitted to the Cleveland Clinic Hospital between 1991 and 1996. - - -●- - - = hospital mortality; —●— = hospital readmissions; and —○— = average length of stay.

(1991) to 1.9% (1996), mean hospital length of stay decreased (from 7.3 to 4.4 days), and the rate of hospital re-admissions at any time during the same calendar year decreased slightly (from 23.0% to 21.3%).

Discussion

Our results show clear trends of decreasing utilization and decreasing cost per patient of respiratory care services as the RTCS has assumed greater participation in allocating respiratory care services for adult non-ICU inpatients at the Cleveland Clinic Hospital. By 1996, protocol-based respiratory care was implemented for virtually all adult non-ICU inpatients in our institution. In the context of available studies suggesting that a respiratory therapy consult service can enhance allocation of respiratory care services to adult inpatients, it is tempting to attribute this temporal trend to the RTCS. However, because correlation cannot establish causality, it is important to critically examine alternative hypotheses that might explain the trends and utilization of respiratory care services we observed.

One such hypothesis is that the trend of decreasing respiratory care utilization demonstrated for the five highest-volume services is divergent from patterns of increasing use for other non-ICU adult inpatient respiratory services, such as tracheal suctioning or continuous oximetry. Although the volume of other non-ICU respiratory services does show a pattern of increasing volume over this time interval (eg, the volume of tracheal suctioning increased by 43% from 1991 to 1996 and continuous oximetry by 218% from 1991 to 1996), these other services actually account for a minority of all respiratory care services (38% in 1996). Furthermore, despite these increases, the overall volume of non-adult ICU inpatient respiratory care services has decreased by 1.6% between 1991 and 1996. As such, their increase does not offset the trend of decreasing use observed for the high-volume services (Fig. 1).

Another alternative hypothesis to explain the observed trends is that appropriateness of respiratory care ordering by physicians improved between 1991 and 1996 and that the trends observed would have occurred independently of the availability of the RTCS. While we believe that the respiratory care algorithms and the handbooks that are distributed to all physicians as part of the RTCS can be an effective teaching mechanism to enhance physician performance, serial evaluations of physician ordering of respiratory care services at the Cleveland Clinic Foundation do not suggest improved physician-directed prescription of respiratory care. For example, our initial retrospective audit in 1987 suggested that 25% of the respiratory care orders made by physicians for 230 adult non-ICU inpatients were deemed unlikely to provide benefit and that 10.6% of these 230 patients were not ordered to receive respiratory care that was indicated.[2] Nine years later in 1996, as part of an observational study comparing RTCS-directed versus physician-directed respiratory care, 43% of the respiratory care orders written by physicians were discordant with a gold standard respiratory care plan that was based on expert application of the American Association for Respiratory Care Clinical Practice Guideline-based algorithms.[6] Also, 72% of the 47 patients receiving physician-directed respiratory care in that study were ordered to receive at least one inappropriate initial respiratory care treatment. Thus, even allowing for the methodologic differences between these two studies, serial analysis of the appropriateness of physicians' orders for respiratory care services at our institution does not suggest improving performance. Therefore, a decrease in the volume and cost per patient of respiratory care services, which is consistent with decreased over-ordering, is not easily explained by physician performance trends.

A third alternative hypothesis is that a migration of patients from adult inpatient wards into the ICUs has occurred as patient severity of illness has risen over time, causing more of the respiratory treatments previously administered to non-ICU patients to be administered in the ICUs. Such a migration might cause an apparent reduction in respiratory treatments to non-ICU adult inpatients. Consistent with this possibility, the number of admissions to the Medical ICU in the Cleveland Clinic Hospital has risen by 91% from 1,029 in 1991 to 1,972 in 1996 with a 2.6-fold rise in the number of these five high-volume respiratory treatments administered to ICU patients (from 39,859 in 1991 to 105,124 in 1996). However, analysis of severity of illness ratings for inpatients at the Cleveland Clinic Hospital suggests that the growth of ICU admissions reflects a general trend toward greater severity of illness of

all hospitalized patients, whether in the ICU or non-ICU wards. Indeed, over the same secular interval (1991 to 1996) that the number of high-volume respiratory treatments administered to adult non-ICU inpatients decreased, the severity of illness of non-ICU adult inpatients increased. Specifically, the average value of the Medicare case mix index (a severity of illness rating, where a higher case mix index indicates higher severity of illness) for adult non-ICU inpatients increased from 1.516 in 1991 to 1.589 in 1996, arguing against decreasing severity of illness as an alternative explanation for the observed decrease in high-volume respiratory care treatments.

Overall, although alternative explanations have been entertained to explain the fall in volume of these five highest-volume respiratory care treatments, the untenability of these alternative explanations supports the idea that implementation of the RTCS over this interval caused the trends we observed.

Clearly, firm evidence that the RTCS enhances allocation (by decreasing over-ordering of respiratory care services) requires showing not only that the volume of services lessens but that the concomitant appropriateness of respiratory care ordering increases. Though addressed in several other studies,[6,8,12,13] the issue of appropriate allocation of respiratory care was only indirectly addressed in this study by data about outcomes of patients with COPD (DRG 088) admitted to our hospital between 1991 and 1996. This analysis showed improved rates of hospital survival and hospital re-admission over the interval when the volume of respiratory care services decreased. While caution is required in explaining this trend, the findings are consistent with the notion that the appropriateness of respiratory care prescribing improved because outcomes were enhanced despite a decreased volume of services.

In the same vein, several important limitations of this study must be mentioned. First, we must reiterate that correlation cannot establish causality, despite our inability to defend an alternative explanation. This limitation of correlational data warrants caution in attributing to the RTCS either the observed decreases in volume and cost of services or the observed changes in outcomes for patients with COPD (DRG 088). Second, although the decreased volume and cost per patient of respiratory care services is consistent with decreased over-ordering, the appropriateness of respiratory care orders was not assessed for all patients in this study. Third, although we believe that decreasing utilization and cost per patient of respiratory care services was favorable in this study (because both length of hospital stay decreased and mortality rate for all inpatients declined between 1991 and 1996), we did not directly assess clinical outcomes for recipients of respiratory care evaluated in this study.

Conclusions

In summary, analysis of trends for using high-volume non-ICU adult inpatient respiratory care services between 1991 and 1996 suggests decreasing utilization overall, decreased per patient use, and commensurately decreased per patient cost for respiratory care services. This trend was concurrent with increasing utilization of a respiratory care protocol program called the Respiratory Therapy Consult Service. Though the temporal coincidence cannot prove that the RTCS accounts for this trend, our analysis does not support alternative hypotheses, strengthening the idea that the RTCS can favorably affect utilization of respiratory care services and decrease costs while also enhancing allocation.

On the basis of these and other data evaluating the efficacy of respiratory care protocols, we recommend the Respiratory Therapy Consult Service as a promising strategy to enhance the allocation of respiratory care services while favoring ongoing study across a broad spectrum of health care institutions to clarify the ideal circumstances for its use.

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Changing Prevalence of Chronically Ventilator-Assisted Individuals in Minnesota: Increases, Characteristics, and the Use of Noninvasive Ventilation

Alexander B Adams MPH RRT, Robert Shapiro MD, and John J Marini MD

BACKGROUND: The prevalence and characteristics of chronically ventilator-assisted individuals (VAI) in the United States are largely unknown. There have been recent changes in the sites and methods of caring for VAIs, as exemplified in the increase in dedicated VAI hospitals and the use of noninvasive positive pressure ventilation (NPPV). To determine the changing prevalence and characteristics of VAIs in Minnesota, we conducted a cross-sectional survey of all VAIs in Minnesota in 1986, 1992, and 1997. METHODS: All providers of care for VAIs responded to similar questionnaires about each VAI in each survey year. Information obtained about VAIs included: age, respiratory diagnosis(es), location, duration of assistance, and need for full or partial support. The 1997 survey included a determination of patients receiving NPPV with a backup rate. RESULTS: At a time when state population increased from 4.26 million (1986) to 4.47 million (1992, +4.9%) to 4.69 million (1997, +5.1%), the number of VAIs in Minnesota increased from 103 VAIs in 1986 to 216 in 1992 (+110%) to 306 in 1997 (+42%). The predominant reason for requiring assistance was ventilatory muscle dysfunction from polio, muscular dystrophy, cervical trauma, or amyotrophic lateral sclerosis (ALS). The most prevalent age groups are <11 and >70 years old. Polio, chronic obstructive pulmonary disease (COPD) and ALS VAIs were older, while those with muscular dystrophy and cervical trauma were younger. There was a bimodal distribution of VAIs in duration of ventilation: those with obstructive and restrictive lung diseases were assisted shorter periods, while the long-term patients (ventilated for >5 years) were those with ventilatory muscle dysfunction. Noninvasive ventilation accounted for 47% of the increase in VAIs between 1992 and 1997. CONCLUSIONS: The number of VAIs in Minnesota continues to increase at a relatively constant rate (≈18/yr), driven by equivalent rises in the number of noninvasive and intubated patients. Ventilatory muscle dysfunction is the predominant disability requiring long-term assistance, while the obstructive-restrictive disease VAIs had a shorter duration of ventilatory assistance. [Respir Care 1998;43(8):643–649] *Key words: Mechanical ventilation—long term, noninvasive positive pressure ventilation, obstructive-restrictive lung disease, ventilator-assisted individuals, ventilatory muscle dysfunction.*

Background

The United States has no registry or national program to account for or coordinate the care of chronically ventilator-assisted individuals (VAI). Therefore, the prevalence, incidence, and characterization of VAIs are largely unknown. Because national programs for VAI care in France and England provide triage and services for VAIs, public health policies there establish the standards, resources, and indications for VAI care.[1] Despite the lack of a coordinated national program in the United States, guidelines for care exist, resources are expended to provide such care,

Alexander B Adams MPH RRT, Robert Shapiro MD, and John J Marini MD are affiliated with Pulmonary Research, Regions Hospital, Robert Shapiro MD, Assistant Professor, and John J Marini MD, Professor, University of Minnesota, St Paul, Minnesota.

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Reprints & Correspondence: Alexander B Adams, Pulmonary Research, Regions Hospital, 640 Jackson St, St Paul MN 55101.

Table 1. The Survey Questionnaire Used in the 1997 Survey of Ventilator-Assisted Individuals in Minnesota.

Survey Questionnaire
1. What is the age of the ventilator-assisted individual?
2. State the diagnosis(es) resulting in respiratory failure, that required ventilatory assistance.
3. For approximately what portion of the day does the individual require mechanical ventilatory support?
4. For approximately how long (months, years) has the individual required mechanical ventilatory support?*
5. How is ventilatory support provided? (positive pressure via tracheostomy, positive pressure by mask with a backup rate,† other)

* = 1992 and 1997 surveys; † = 1997 survey only

and indications for VAI care have been published.[2,3] VAI care, however, is delivered by regionally inconsistent resources and reimbursements. Intrastate surveys indicate that a substantial number of VAIs are cared for in the United States and the number is probably growing.[4–6]

Recent changes in the care delivery for VAIs may have changed the number of patients, indications for care, methods for ventilatory assistance, and sites of care delivery. There has been an increase in the number of specialized care centers, extended care facilities, and homes equipped to care for VAIs. In addition, a concern for rising health care costs could have affected the number of VAIs, their venue, and the tendency to use less costly treatment options (such as noninvasive ventilation).[7–9] Within the past several years, innovative methods and adjunctive techniques have been described to reduce or eliminate the need for ventilatory support.[10–13] In light of the increases in resources and the use of techniques available to reduce the need for assistance, it is not clear how the number or characteristics of VAIs have been affected by these changes.

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In 1986 and 1992, complete cross-sectional surveys of VAIs were conducted in Minnesota.[6] Between those years there was a 110% increase in the number of VAIs. The increase was attributed to a broader availability of resources and clearer indications for care. Assuming a uniform distribution of VAIs throughout the country, the 1992 survey estimated 12,279 VAIs in the United States. The VAIs in Minnesota were characterized by locations, disease conditions, and diagnostic categories. From 1992 to 1997, we anticipated that cost constraints and changes in the care settings and the availability of techniques to reduce or prevent the need for ventilatory assistance might have affected the number of VAIs, their sites of care, or the methods used for ventilatory assistance. To examine this question we repeated a complete survey of VAIs to account for and characterize possible changes in the prevalence and management of VAIs, using the same methods applied in 1986 and 1992.

Methods

We contacted all agencies, dedicated VAI care units within hospital settings, skilled nursing facilities, and group homes that were providing care for VAIs. Individuals responsible for the records of VAIs completed the questionnaire in Table 1. As in the previous surveys, we defined a VAI as an individual receiving ventilatory assistance for at least 6 h/day for more than 30 days. No patients receiving noninvasive positive pressure ventilation (NPPV) support were reported by the providers in the 1986 and 1992 surveys. We assume that the earlier surveys were conducted before NPPV was in use in Minnesota (the surveys were actually conducted in mid 1986 and early 1992). The present survey included those receiving NPPV only if their ventilator settings included a backup respiratory rate—a VAI status requiring service/supplies and a reimbursement category for certain third party payers. Patients receiving NPPV using a completely spontaneous mode (ie, continuous positive airway pressure, or CPAP, or NPPV in a spontaneous mode) were excluded. These criteria will underestimate total NPPV use, but the providers could only assure complete information on such VAIs with backup respiratory rate. Survey responses were followed up by telecopy and telephone to verify information, but diagnoses were not independently verified.

Results

Between 1992 and 1997 the number of VAIs in Minnesota increased from 216 to 306 (+42%) (Fig. 1). When compared to the 1992 survey, there was an increase in dedicated care units for VAIs from 4 to 7; agencies providing VAI care increased from 12 to 18; and 3 group homes were newly established for VAI care. The proportion of VAIs living at home remained relatively constant between 1992 and 1997 (65%, 1992; 67%, 1997). The proportion of those receiving partial support (<24 h/day) remained unchanged from 1992 (35%, 1992; 35%, 1997). There were changes in the age distribution categories between the study years (Fig. 2). Those less than 11 years old

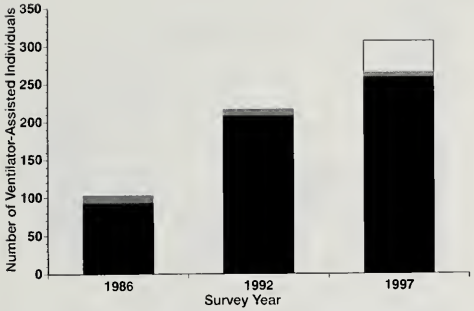

Fig. 1. Number of ventilator-assisted individuals for the three surveys and their method of assistance. □ = noninvasive positive pressure ventilation (NPPV); □ = other methods of noninvasive ventilation (Noninvasive—Other), such as rocking bed, cuirass, poncho, or tank respirator; ■ = positive pressure via tracheostomy (Tracheostomy).

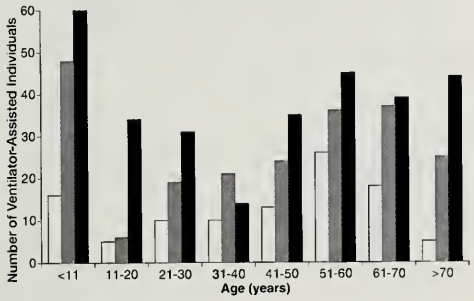

Fig. 2. Number of ventilator-assisted individuals by decile age group for the three surveys. □ = 1986; □ = 1992; ■ = 1997.

remain the largest age group, while increases were greatest in the 11- to 20-year-old and over 70 age groups.

The five most prevalent diagnoses for VAIs were unchanged between 1992 and 1997, but their distribution and ranking differed between the survey years (Fig. 3). Cervical trauma and muscular dystrophy are now the most prevalent diagnoses; polio had been the most prevalent diagnosis in 1992 and 1986. Between the 1992 and 1997 survey years, the prevalence of VAIs with muscular dystrophy increased by 110%, of COPD by 90%, and cervical trauma by 24%. In contrast, polio decreased by 9% and amyotrophic lateral sclerosis (ALS) decreased by 36%.

There were differences in median age and mean duration of assistance (Table 2) between the most prevalent diagnoses. Median age of patients with cervical trauma was 30 years, and muscular dystrophy was 29 years. The chronic obstructive pulmonary disease (COPD) and polio VAIs were older, at median ages of 68 and 62 years, respectively. The median age for the "others" group was only 14 years. The mean duration of assistance for COPD was only 19.7 months as compared to 53.4 for cervical trauma, 73.7 for muscular dystrophy, and 224.6 months for polio.

To further characterize VAIs, a recommended classification system[2] was used to assign the diagnoses of VAIs into five diagnostic categories for chronic respiratory failure: ventilatory muscle dysfunction, central hypoventilation, obstructive disease, restrictive disease, and miscellaneous. The distribution among categories for the three survey years is shown in Table 3. As in each previous survey, ventilatory muscle dysfunction continues as the predominant diagnostic category of chronic respiratory failure. Of note, only 25% of the total number of VAIs in the 1997 survey have an obstructive or restrictive lung disease. When the categories of ventilatory muscle dysfunction and a combined category of obstructive-restrictive disease are compared by duration of assistance, a bimodal distribution was observed (Fig. 4). Those with obstructive-restrictive lung disease were assisted for shorter durations, while those with ventilatory muscle dysfunction (polio, muscular dystrophy, cervical trauma) were ventilated longer.

Of the total increase in VAIs between 1992 and 1997, nearly half (47%) can be attributed to the inclusion of patients using NPPV (Fig. 1). Those receiving NPPV were not confined to a specific diagnosis or diagnostic category (Table 4). NPPV was prescribed for each major diagnosis and each diagnostic category. In addition, 16 of those receiving NPPV were younger than 16 years. Four agencies provided ventilators and supportive care exclusively for NPPV (excluding tracheostomy patients).

Discussion

This study is the third cross-sectional survey of VAIs in Minnesota intended to characterize this condition and determine the prevalence of patients receiving ventilatory assistance for chronic respiratory failure. The surveys are considered complete and not a sampling of intubated VAIs. The reporting of VAIs receiving NPPV included only those assisted with a backup rate, which underestimates total NPPV use, but reports information on a specific application of NPPV for chronic respiratory failure. The completeness of the surveys was assured by tracking the ventilators; that is, ventilators in use require service that providers must supply and the provider records also include information about the ventilated patient. We polled all of the finite number of care providers in Minnesota. By providing the assurance of anonymity, we obtained the uniform cooperation of those involved.

As in the 1992 survey, we found a continuing increase in VAIs. Comparing the three surveys, the 110% increase

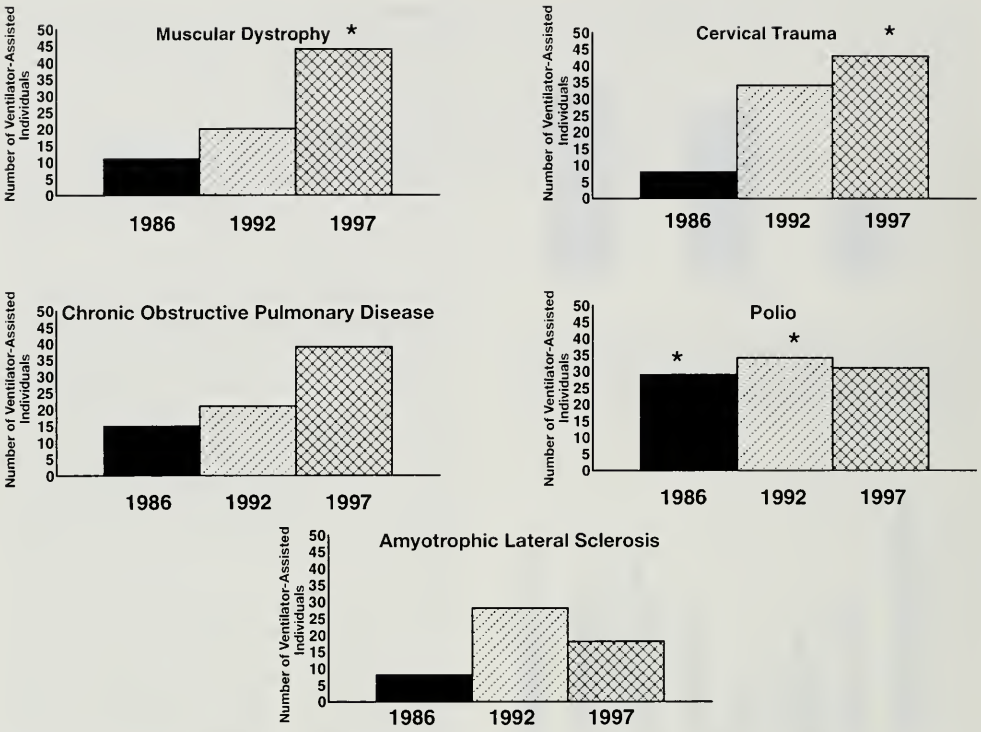

Fig. 3. Number of ventilator-assisted individuals for the five most prevalent diagnoses in each of the survey years. * = most prevalent for the survey year.

Table 2. Diagnoses, Number, Median Age and Mean Duration of Assistance of Ventilator-Assisted Individuals from the 1997 Survey.

	N	Age (median, years)	Duration of Assistance (mean, months)
Cervical trauma	42	30	53.4
Muscular dystrophy	42	29	73.7
Chronic obstructive pulmonary disease	40	68	19.7
Polio	31	62	224.6
Amyotrophic lateral sclerosis	18	56	33.0
Others (33 diagnoses)	133	14	38.8

between 1986 and 1992 exceeded the 42% increase between 1992 and 1997. However, the increases represent a fairly constant number of VAIs added per year; 18.8/yr between 1986 and 1992 and 18.0/yr between 1992 and 1997.

Table 3. Number of Ventilator-Assisted Individuals (% Total) by Diagnostic Category for the Three Surveys.

	1986	1992	1997
Ventilatory muscle dysfunction	63 (61)	134 (62)	163 (53)
Obstructive disease	16 (16)	33 (15)	51 (17)
Restrictive disease	0	9 (4)	23 (8)
Central hypoventilation syndrome	8 (8)	19 (8)	48 (16)
Miscellaneous or unknown	16 (16)	21 (10)	21 (7)
Total	103	216	306

Proportional increases in resources, such as the increase in dedicated facilities and agencies providing care, have accompanied the increasing number of VAIs. In addition, the number of VAIs at home continues to increase proportionately to the total increase. At home, VAIs can have more independence and, if family members are care providers, home ventilation offers a less costly option.[6,14,15] The facilities and agencies are concentrated in the major

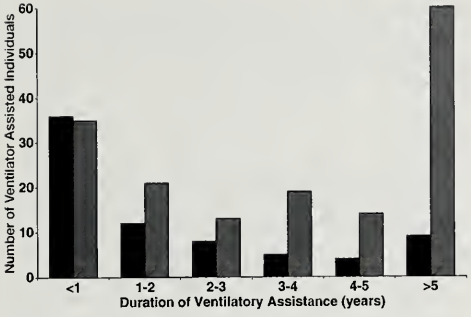

Fig. 4. Number of ventilator-assisted individuals versus duration of assistance for obstructive-restrictive diseases and ventilatory muscle dysfunction in 1997. ■ = obstructive-restrictive diseases; ▦ = ventilatory muscle dysfunction.

Table 4. Number of Ventilator-Assisted Individuals Receiving Noninvasive Positive Pressure Ventilation by Diagnosis (or Category)—Pediatric (<16 years old), Adult (>16 years old) and Total.

	Pediatric	Adult	Total
Sleep disorders	6	3	9
Congenital abnormalities	6	2	8
Muscular dystrophy	0	5	5
Amyotrophic lateral sclerosis	0	5	5
Chronic obstructive pulmonary disease	0	4	4
Polio	0	3	3
Brain tumor	2	0	2
Cystic fibrosis	1	1	2
Cervical trauma	1	1	2
Kyphoscoliosis	0	2	2

metropolitan areas. Generally, rural VAI care is not as readily available.

The assumption of uniform distribution of VAIs throughout the United States must be made with caution because health care resources, access, and policy vary widely from state to state. Nevertheless, an extrapolation of the 1997 data to the entire country predicts 17,824 VAIs for the United States. This compares to the Make survey from Massachusetts[4] in 1983, that estimated 6,000 VAIs for the United States in that year and to the Goldberg survey from Illinois[5] in 1990, that estimated over 10,000. The Minnesota surveys estimated 5,777 VAIs in 1986 and 12,279 VAIs in 1992.[6] Although survey methods and VAI definitions differed, the five surveys taken together suggest an increase of approximately 1,000/yr for the United States over the 14-year span of the intrastate surveys.

The Minnesota surveys demonstrate certain characteristics for VAI diagnoses and general diagnostic categories. Muscular dystrophy and cervical trauma are the most prevalent diagnoses in 1997 with similar median ages and similar durations of assistance. Along with the polio VAIs (who are much older), these three diagnoses comprise the majority of those with structural dysfunction of the ventilatory muscles. These patients without primary lung disease comprise a significant portion of the chronically assisted patients (those with the greatest durations of assistance). The categories with shorter durations of assistance are VAIs with COPD who tend to be older and VAIs with restrictive diseases. Of interest is the median age of 14 years for VAIs other than the five most prevalent diagnoses. This low median age reflects the large number of young VAIs with a variety of congenital and birth-related abnormalities; there were 24 distinct diagnoses for VAIs under 21 years old.

Not discernible from these surveys is the incidence rate of chronic ventilator dependence, because we lack longitudinal information on the initiation and termination of ventilatory assistance. Because we are not aware of the incidence rates in Minnesota for the primary diagnoses of VAIs, we cannot speculate on whether the changes we found in VAI prevalence are associated with changes in disease incidence. For example, we cannot explain the decrease in VAIs with ALS from 1992 to 1997 by a change in incidence of ALS.

Reports from respiratory units and regional weaning centers throughout the country indicate the diagnoses and weaning success rates of patients entering their centers.[16–19] Patients admitted to these facilities will successfully wean from ventilatory support, die, or become part of the VAI population. Scheinhorn et al[18] reported that 81% of 1,123 patients treated at a regional weaning center had chronic lung disease, acute lung disease, or postoperative problems. Bagley and Cooney[19] reported on 278 patients from their center with weaning success rates of 58% for postoperative causes, 57% for acute lung injury, 22% for COPD, and 22% for neuromuscular diseases. Gracey et al[17] reported a weaning success rate of 87% from a specialized respiratory unit within an acute care facility. From a prolonged respiratory care unit, Indihar[16] reported a weaning success rate of 34% where, at that time, VAIs were in residence. These centers report relatively few admissions with neuromuscular diseases. These studies, then, imply that a majority of 'early' VAIs have postoperative problems or obstructive or acute lung disease, of which a significant proportion will be weaned from support. A smaller number will have neuromuscular causes with a lower likelihood of weaning. The weaning success rates from these reports range from 34% to 87%, reflecting, most probably, the patient mix differences related to the proportion of primary lung disease (obstructive and restrictive disorders) versus ventilatory muscle dysfunction and the time elapsed

since the intensive care admission (related to the time available for weaning).

These reports are from experiences at specific VAI care settings. The Minnesota surveys account for patients from all settings: specialized respiratory units, regional weaning centers, extended care facilities, group homes, and home patients. Our survey results indicate three patient groups with overlap: VAIs with primary lung disease (obstructive and restrictive diseases) and a short duration of assistance, VAIs with ventilatory muscle dysfunction and a longer duration of assistance, and VAIs under 20 years old with a variety of diagnoses (others—33 diagnoses).

The consistent definition of a VAI for the Minnesota surveys is from an American College of Chest Physicians position statement in 1986 generated before the widespread introduction of NPPV.[2] NPPV has been extensively used to avoid endotracheal intubation in acute care situations.[20–23] NPPV may also successfully support chronic respiratory failure caused by restrictive chest wall diseases and ventilatory muscle dysfunction.[8,9] The evidence for the value of NPPV in treating chronic respiratory failure in COPD patients is less convincing.[24] The use of CPAP or a spontaneous breathing mode (although not considered assisted ventilation) is well accepted in the treatment of sleep disorders, and NPPV is indicated for a minority of sleep disorder patients. Since 1992 there have been significant developments in the methods, apparati, and ventilators that implement NPPV. The 1997 survey found that, in Minnesota, NPPV has been prescribed for all of the major VAI diagnoses without a predominant diagnosis such as sleep disorders. NPPV accounted for 47% of the increase in VAIs between 1992 and 1997 and is now 16% of the total VAIs. Because the survey was able to track only those receiving NPPV using a backup rate, we would presume that the limited definition for NPPV underestimates the total VAIs receiving this form of support.

The results from these surveys have certain weaknesses. As already noted, with cross-sectional data, we can only speculate regarding incidence rates. For example, we are viewing three VAI pools, and VAIs that start and end assistance between study years are not counted. Furthermore, although the surveys are complete for invasive ventilation, we have only a sampling of the total data on NPPV. While most diagnoses were quite distinct, diagnoses for several congenital abnormalities and for patients with multiple diagnoses were classified without verification by chart review and, therefore, may have been inaccurately classified. An expert on congenital abnormalities was consulted to assist in accurate classification of these disorders. For patients receiving care from an agency and at a facility, double counting was possible. Cross-checking of VAIs with similar ages and diagnoses excluded four cases of double counting. Finally, without verification of information from other sources, we cannot completely exclude transcription errors in reporting, care providers existing outside of the known network of providers, or unreported VAIs from known providers; yet, to our knowledge the surveys are complete.

Conclusions

These surveys describe the prevalence of VAIs in Minnesota at three time points, with a constant rate of increase of approximately 18/yr. Certain characteristics of VAIs in Minnesota have been identified; a majority of those receiving assistance for a shorter duration have obstructive-restrictive lung diseases while the chronic VAIs are, primarily, those with ventilatory muscle dysfunction. The inclusion of even a limited definition of NPPV in the 1997 survey accounts for 47% of the increase in the past 5 years; therefore, NPPV is assuming an important role in treating VAIs.

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Continuous Pulse Oximetry and Patient Outcomes: A Skeptical View

"Sacred cows make the best hamburger."
—Mark Twain

Introduction

Few recent phenomena in health services research have generated as much ink as outcomes research and management. In broad terms, outcomes research and management involve measuring how well our processes of care work and then developing interventions and systems to improve those processes. Specifically, outcomes can be defined as those changes in the actual or potential health status of persons, groups, or communities that can be attributed to the processes of care. What is included in the category of outcomes depends, therefore, on how narrowly or broadly one defines health and the corresponding responsibilities of clinicians or the health care system as a whole. To the casual observer, it may sound as if this is a restatement of what has been happening in the health care field for the last 100 years. But, ". . . new technologies and procedures have developed so rapidly—and there are such economic and social incentives to use them—that the evaluation of their safety, efficacy, and cost-effectiveness as well as the consideration of their social and ethical consequences has lagged far behind."[1]

While some modern medical interventions are regarded as stunning successes (such as surgical procedures in cardiology, obstetrics, and trauma care, to name only a few), the truth is that most of what we do has never been tested. The office of technology assessment estimates that only 10–20% of modern medical interventions have ever been tested for their effect on outcomes.[2,3] This does not necessarily mean that these untested interventions and practices are wrong, but they may not represent the most efficacious patient care.

Physiologic monitors are an example of a class of interventions that have been subjected to little rigorous outcomes research. During the last 25 years, there has been a tremendous growth in the availability and use of various types of physiologic monitors, including (but certainly not limited to) continuous monitoring of: pulse oximetry, heart rate, respiratory rate, blood gases, exhaled CO_2, systemic venous oxygen saturation, airway pressure and flow, core and skin body temperatures, systemic and pulmonary blood pressures, capillary wedge pressures, cardiac output, fetal heart rate, and fetal oxygen saturation. It would be difficult to determine exactly what the advent of these types of monitors has cost the health care system, but the costs associated with escalating technology surely account for a substantial proportion of the recent increases in overall health care costs. I estimate that a fully equipped intensive care unit (ICU) bed in the U.S. has approximately $50,000 worth of monitoring equipment (this, of course, does not include ventilators, dialysis machines, specialty beds, infusion pumps). It is reported that there are 96,707 intensive care beds in the U.S.[4] If one assumes that only one half to two thirds of the beds are fully equipped (a conservative estimate) with monitoring equipment, the U.S. hospital industry may have spent $2.5 to 3.2 billion (or perhaps even more) equipping these beds with monitoring devices. And, of course, the excellent marketing efforts of physiologic monitor manufacturers have convinced us that we must re-equip these beds every few years, so that we have the latest monitoring features.

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What exactly are we getting for this money? As I stated earlier, there has been little investigation into how the use of these types of monitors affects outcomes. By this I mean do they increase survival or speed recovery from disease or reduce complications of care or ease pain and suffering or reduce the costs of care? While a great deal of investigation has gone into whether these devices accurately measure what they are supposed to, what we do not know is whether making these measurements (and presumably acting upon them) will affect the outcome of patient care.

Among the things outcomes research seeks to identify are practices and interventions that affect the outcomes of care processes, either beneficially or adversely. The classic method of doing outcomes research is the randomized clinical trial in which patients are randomly selected to either receive or not receive the intervention in question. The groups of patients are then compared to determine if receiving the intervention influenced the outcome of their

disease. Unfortunately, there are few controlled-randomized trials studying the utility of monitoring technology.

Outcomes of the Use of Continuous Pulse Oximetry

Pulse oximetry is an example of monitoring technology that has been widely used but has little if any proven effect on outcome. Most of the published investigations (of which there are hundreds) concerning oximetry are focused almost entirely on whether or not the devices accurately measured oxygen saturation in various populations.[5,6] The positive findings of early studies led to the use of oximetry in the operating room, emergency room, ICU, and, eventually, almost every part of the hospital.

However, there still are many unanswered questions about pulse oximetry. Principal among these are: (1) What are the range of normal variations in saturation in healthy and ill populations? (2) Does it matter whether such variations are identified and treated (minimized)? Considering the extent to which pulse oximetry has proliferated, there is not nearly as much investigation into outcomes from monitoring as one would have hoped, but there are *some* investigations that merit review.

Variations in Oximetry Readings

There is an emerging body of evidence that illustrates the range of variation in oxygen saturation readings. Rosenberg and colleagues[7] studied the frequency and magnitude of clinically occult desaturations in sleeping, otherwise healthy, elderly patients before and after hip-replacement surgery. They documented that episodic desaturation to <80% occurred in 13 of 22 patients after surgery, *and* in 4 of 22 patients before surgery. They also documented that these desaturations resulted in changes in these patients electrocardiograms that included electrocardiograph ST wave segment depression, tachycardia, increased frequency of premature ventricular contractions, and others. However, they found no postoperative cardiac complications that required treatment or adverse outcomes in any of these patients. Thus, they showed that episodic hypoxemia appears to be a normal occurrence in some patients and that it does not appear to be linked to adverse outcomes. Although their sample size was admittedly small, it might be argued that the study was designed to identify 'markers' of poor outcomes.

In a follow-up study,[8] the same researchers randomized a similar sample patient population to receive oxygen via a simple oxygen mask while sleeping on the second postoperative night. They discovered no significant differences in the number of hypoxemic episodes in the group with or the group without the oxygen mask! The authors concluded that oxygen therapy in this population did not, "... influence the basic mechanism leading to episodic hypoxemia." There was also no difference in overall mortality or morbidity between the patients who did and did not receive the oxygen. Although the authors might disagree, I interpreted these data to suggest that not only did it not matter whether such desaturations are monitored, it does not seem to matter whether they are treated! And yet, continuous monitoring with a pulse oximeter is considered by some to be a standard of care for monitoring patients in the postoperative period.

We can further understand the considerable variations in saturation readings even in healthy populations when we consider the study by Thilo and colleagues[9] performed in Denver (altitude 5,280 ft). In the study, serial pulse oximetry was performed on 150 healthy infants ages 1–3 months. As expected, the altitude had the affect of lowering the average waking saturation to 92–93%. It is interesting to note that during feeding, the lower limit of the 95% confidence interval (or normal range) for S_{pO_2}, readings were 85%, and during sleep, 86%. The altitude at which this study was done certainly accounts for some portion of these low values. But even if one accepts that saturations at that altitude are 3–5% lower than classic 'normals,' the low end of this distribution of readings would be approximately 88–90% while sleeping or eating even adjusting for altitude. At our facility in Salt Lake City (a similar altitude), children are still routinely treated with oxygen for saturations less than 92%. While such treatment with oxygen is generally benign, we are very concerned that discharge is sometimes delayed because of these 'marginal' saturation readings, and that some patients are admitted because of these allegedly 'abnormal' findings. We seem at times to be unable to accept that there is considerable 'normal' variation in oxygen saturation readings.

This large amount of variation may account for why pulse oximetry sometimes correlates poorly with other physical findings of respiratory disease. Alario and colleagues[10] acquired pulse oximeter readings before and after treatment for wheezing in 74 infants and children (ages 1–36 months) who presented with acute wheezing. They compared oximetry findings with clinical response to treatment measured by respiratory rate and a standardized index of respiratory distress. They found that the post-treatment oximetry readings yielded a high degree of individual variability. They concluded, "After therapy, young children can appear clinically improved but measured oxygen saturation may be variable and not correlated with traditional clinical assessment. In fact, in assessing the response to therapy for an individual patient, the S_{aO_2} may be misleading." It is interesting to note that instead of suggesting that clinicians trust their clinical assessment skills and not rely heavily on the 'numbers' generated by the oximeter, the authors try to defend the inability of the oximeter to agree with their eyes and ears. They suggest that "the

traditional clinical evaluation may be assessing different pathophysiologic constructs than those assessed by oximetry." I am beginning to understand part of what Robert Mendelsohn MD meant is his classic work, *Confessions of a Medical Heretic** when he suggested that the practice of modern medicine is neither an art nor a science, but is instead a religion.

Oximetry and Outcomes

In one of the few large randomized trials of continuous pulse oximetry, Moller and colleagues[11] enrolled more than 20,800 surgical patients in Denmark and randomized them to receive continuous pulse oximetry during surgery and in the recovery room. The two groups did not differ significantly in cardiovascular, respiratory, neurologic, or infectious complications, length of hospital stay, or in-hospital deaths. Indeed, the oximeters prompted a number of changes in patient care (improvements in the process of care) but apparently had no effect on overall complication rates (the outcomes of care). It may be argued that some of these end points or outcomes, notably cardiac infarctions or death, are so infrequent in healthy patients that it is unlikely that a difference in outcome could be shown, even in a study of this size. However, the authors themselves did *a priori* power analysis computations, determining that their design had a 90% chance (β) of capturing differences of about 25% in any respiratory or cardiovascular complication in aggregate. Others have computed that 500,000 to 1,900,000 cases would need to be studied to specifically detect cardiac arrest, brain injury, or death.[12]

What is interesting about this study is the reaction it yielded. Editorials were written and arguments put forth for why, in spite of an admitted lack of compelling evidence, continuous pulse oximetry should continue to be the standard of care.[12,13] Arguments included: (1) it is now the standard of care and should not be abandoned (everyone's doing it, so it must be appropriate); (2) the hitherto rigorous standards of demonstrating statistical significance in research findings (probability of erroneously rejecting that the null hypothesis be $<5\%$) be abandoned in the case of outcomes from oximetry because it would be too difficult to prove.

It should also be noted that when presented with the negative results of this study, the anesthesiologists at the Moeller et al's institution still wanted to use oximeters. One wonders whether this is because of the therapeutic effect on the providers or on the patients. Arguing that a practice has validity because everyone does it reminds me of the efforts of Holmes and Semmelweis[14] to convince obstetricians in the middle of the 19th century to wash their hands between conducting autopsies and doing vaginal examinations on pregnant women. In spite of immediate and profound decreases in mortality, the obstetrical community at large refused to embrace these findings for many years, and insisted on continuing their current practice of not washing their hands.

In this same paper, Moller and colleagues report that 18% of a self-selected (and, hence, biased) sample of anesthesiologists reported in a survey that serious complications were *possibly* prevented by using a pulse oximeter.

What this study did show was the unsurprising finding that subclinical episodic hypoxemia was identified much more frequently in the monitored group. However, since these episodes were undetected and, thus, untreated in the monitored group, this apparently had no effect on the outcomes measured in this study.

The findings of Moller et al's investigations notwithstanding, it might be possible that not using the pulse oximeter and, thereby, not identifying and treating episodic hypoxemia have more subtle effects on higher brain functions such as memory and cognition. Moller and colleagues[15] set out to answer this question as well by randomizing 736 surgical patients to continuous pulse oximetry during surgery and in the recovery room. Cognitive function was evaluated in the two groups using both subjective and objective assessments before, at seven days after, and at six weeks following surgery. While there were some subjective findings of postoperative cognitive impairment in some patients in both groups, the authors concluded that, ". . . subjective and objective measures did not indicate less postoperative cognitive impairment after perioperative monitoring with pulse oximetry." Moller[16] has done an excellent job of summarizing these findings and those of many other researchers in his 1994 monograph on oximetry published in the Danish Medical Bulletin.

Continuous pulse oximetry is sometimes used in general medical-surgical populations even though there has been no compelling research to support the utility of this practice. When the impact of these monitors has been studied, little or no benefit has been revealed. Bowton and colleagues[17] studied 147 general medical-surgical patients monitored with a pulse oximeter that recorded all patient desaturations. Daily reviews of the oximeter records were compared with the nurses' charting, doctors' progress notes, and doctors' orders. Desaturations that were identified by the pulse oximeter were noted in the nursing notes only 33% of the time and in the doctors progress notes 7% of the time. Changes in the orders for respiratory therapy were noted in only 20% of patients who desaturated to $<85\%$. Thus, continuously using the pulse oximeter on these patients, presumably to identify and treat otherwise

* Mendelsohn RS. Confessions of a medical heretic. Chicago: Contemporary Books Inc, 1979.

occult hypoxemia, did not seem to achieve the desired outcome.

The use of continuous pulse oximetry in general medical-surgical populations is particularly widespread in pediatric hospitals. In an unpublished survey (Salyer JW, unpublished data, 1997) of more than 1,000 hospitals, I found that nearly one third of tertiary pediatric hospitals reported continuous monitoring with a pulse oximeter of as many as 60% of general medical-surgical patients.

At Primary Children's Medical Center, we were able to effect a 21% reduction in the use of continuous pulse oximetry between 1992 and 1994 outside our intensive care units and operating rooms.[18] During this same period of time, average length of stay decreased by more than 0.5 days. While there are many factors that affect length of stay, if reduction in the use of continuous pulse oximetry had an adverse effect on outcomes, in that we were not monitoring patients that should have been monitored, we could postulate that the length of stay should have increased. It is unfortunate that we have been unable to sustain these decreases in the use of pulse oximetry.

Bierman et al[19] published a report of a randomized trial of continuous pulse oximetry in the ICU that is often cited as evidence supporting the use of pulse oximetry. Thirty-five postoperative cardiac-surgical patients were all monitored continuously with a pulse oximeter. Oximetry values were available to the bedside staff in one group; while the other group's oximetry values were monitored in a remote location and reported to the bedside personnel only after 5–10 minutes, allowing the bedside staff to detect and react to hypoxemia episodes based on clinical assessment alone. Episodic hypoxemia undetected by the clinical staff was found in 7 of 15 patients in the group blinded to oximeter readings. The authors reported fewer blood gases in the group that had the readings available at the bedside, but their design was such that the blinded group had routine blood gases, collected every six hours, while the other group was tested only as needed. It is not surprising that the blinded group had more blood gases analyzed. Length of ventilation, length of oxygenation, and number of ventilator changes were not different between the two groups. This study confirmed that the pulse oximeter helps to detect episodic hypoxemia, but the design did not allow for testing whether treating these episodes had any impact on outcome.

Summary

It is now axiomatic that continuous pulse oximetry is a standard of care for ICU patients. I have little hope that we will ever rigorously test this assumption; the use of continuous pulse oximetry on virtually every patient in the ICU will be the standard of care for the foreseeable future.

However, lately I have seen a lot of manufacturers' literature regarding the utility of continuous monitoring in the general medical-surgical population. I hope that we have not gone down that road too far to stop and assess whether we are offering our patients anything with pulse oximetry besides a larger bill.

There may be a measurable role for continuous pulse oximetry in the inpatient, non-ICU setting. It is unfortunate that we have accomplished little in determining what that role is. It is suggested that there is indirect evidence of the benefit of pulse oximetry in certain settings. One example is the reduction in anesthesia malpractice premiums since the introduction of pulse oximetry. However, malpractice premiums might have decreased for other reasons too, including a possible general increase in the diligence of anesthesiologists. The fact that the insurance companies offer lower premiums to those who used oximeters may reflect a business decision made more in desperation than evidence in support of the salutary effect of oximeters on patient outcomes.

Respiratory care clinicians can and should lead the efforts to help the medical community examine the impact of continuous pulse oximetry and other respiratory monitoring technologies on outcomes. Our technology continues to develop at an ever-increasing pace. Let us hope that our wisdom can keep pace, and we can get better at determining when to (and when not to) apply this technology.

John W Salyer RRT
Director, Outcomes Research Service
Primary Children's Medical Center
Adjunct Assistant Professor of Pediatrics
School of Medicine
University of Utah
Salt Lake City, Utah

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Reprints & Correspondence: John W Salyer RRT, Primary Children's Medical Center, Respiratory Care, 100 N Medical Drive, Salt Lake City UT 84113-1100, e-mail: pcjsalye@ihc.com.

Administration of Sedative and Analgesic Medications by Respiratory Care Practitioners: A Position Statement from the American Association for Respiratory Care

The American Association for Respiratory Care (AARC) recognizes the fact that Respiratory Care Practitioners are called upon to assist physicians with the administration of sedative and analgesic medications during diagnostic and therapeutic procedures.

"Sedation" and "analgesia" describe a physical state in which the patient is able to tolerate unpleasant procedures, while maintaining adequate cardiorespiratory function, and the ability to respond purposefully to verbal commands and tactile stimulation. The AARC believes that RCPs working under direct medical supervision can assist physicians during diagnostic and therapeutic procedures, and help to minimize risks by administering prescribed medications and closely monitoring the patient.

The AARC recognizes and acknowledges the following:

- The American Society of Anesthesiologists (ASA) has published the document "Practice Guidelines for Sedation and Analgesia by Non-anesthesiologists."

- The purpose of the ASA document is to allow clinicians to provide their patients with the benefits of sedation and analgesia while minimizing associated risks.

- The ASA Guidelines should be followed by all RCPs called upon to provide this service.

- The clinicians and their facilities have the ultimate responsibility for selecting patients, procedures, medications, and equipment.

- Respiratory care training programs approved by the Commission on Accreditation of Allied Health Education Programs/Committee on Accreditation of Respiratory Care (or their successor organizations) provide appropriate pharmacologic and technologic training to enable RCPs who have successfully completed a formal training and competency assessment program working under medical direction and under direct orders from a physician to safely administer sedatives and analgesics (by whatever routes and in whatever doses of medication selected by the physician) by following the ASA Guidelines.

Following successful completion of a formal training and competency assessment program the RCP must:

- Be knowledgeable about the techniques, medications, side effects, monitoring devices, response or untoward effects of medications, and documentation for any specific procedure.

- Meet qualifications to be certified as competent, in accordance with her/his facility's and Respiratory Care Service's policy, to administer sedatives and analgesics under medical supervision and the direct orders of the physician performing the procedure, or the anesthesiologist in attendance.

The AARC affirms that RCPs who have successfully completed a formal training and competency assessment program on sedation and analgesia based on the ASA's Guidelines, and who have been certified as competent by the appropriate medical director and department head or governing body should be permitted to provide the service in accordance with ASA's Guidelines, facility policies, procedures, protocols, and service operations, as well as with Joint Committee for the Accreditation of Healthcare Organizations and state requirements and policies.

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Practice guidelines for sedation and analgesia by non-anesthesiologists. Anesthesiology 1996;84:459–471.

Letters

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Will the Correct Units for Hemodynamic Monitoring Please Come Forward?

As an educator in respiratory care with an interest in hemodynamic monitoring, I frequently have discussions with colleagues about the correct units for vascular resistance, both systemic and pulmonary. My understanding is: Resistance is defined generically as $\Delta P/\dot{Q}$ (flow). For use in cardiovascular and pulmonary physiology, pressure has units of dyne/cm^2; flow has units of cm^3/s. Inserting them into the generic equation yields:

$$R = \frac{\text{dyne/cm}^2}{\text{cm}^3/\text{s}}.$$

Simplifying this yields

$$R = \frac{\text{dyne} \cdot \text{s}}{\text{cm}^2 \cdot \text{cm}^3}, \text{ or}$$

$$R = \text{dyne} \cdot s \cdot \text{cm}^{-5}.$$

A perusal of textbooks, however, reveals a lack of consistency on this, with many authors using the units of dyne/sec/cm^{-5}. This is, of course, most confusing for students. To further confound the picture, one text has changed the units from one edition to the next. In no particular order, the following books use dyne · sec · cm^{-5}: Oakes,[1] Persing,[2] Des Jardins,[3] Des Jardins and Tietsort,[4] Beachey,[5] Sills,[6] West,[7] Ouellet,[8] and Slonim and Hamilton.[9] Strangely enough, the books using the 'incorrect' units of dyne/sec/cm^{-5} are specifically hemodynamic monitoring texts—Daily and Schroeder's monitoring book,[10] Daily and Schroeder's hemodynamic waveforms book,[11] and Darovic.[12] Darovic is also inconsistent within her text and equations, variously using dyne/sec/cm^{-5} and dyne sec/cm^{-5} (with no mathematical operator between dyne and sec). Shapiro and colleagues appear to have 'gotten religion' between their third edition,[13] in which they used the units of dyne/sec/cm^{-5} and their fourth edition[14] in which they used the units dyne-sec/cm^{-5} (which is the algebraic equivalent of dyne · sec · cm^{-5}). Even a respected nursing critical care textbook uses the 'wrong' units.[15]

It is no surprise that students are confused, even though those textbooks using the 'correct' units outnumber those using 'incorrect' units by 3-to-1 in this survey in which I used a convenience sample (these books were in my office and my colleagues' offices.) Our lack of surprise at the students' confusion does nothing to help the situation, however. Even the National Board for Respiratory Care (NBRC) uses dyne/sec/cm^{-5} in the most recent *RRT Study Guide*.[16] (Note: I have talked with the president of the NBRC, who indicated that they agree with my assessment of what constitutes the correct units; the determination of what form will be used for the NBRC examinations will be made at the next board meeting.)

What to do? I feel that doing the algebra (as shown) is the best and, really, the only way to convince the nonbelievers.

I would be interested in hearing from other educators (all clinicians, actually) who have had this problem and how they have handled it—especially when the hemodynamic profile sheet in your hospital's medical-surgical intensive care unit uses dyne/sec/cm^{-5} for vascular resistance. I would also appreciate receiving other examples of the usage of 'incorrect' units in published works, as I am making a collection.

Robert R Fluck Jr MS RRT
Associate Professor and
Clinical Coordinator
Department of Cardiorespiratory Sciences
SUNY—Health Science Center
Syracuse, New York

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Books, Films, Tapes, & Software

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Sym*Bio*Sys™ Arterial Blood Gas Interpretation. System requirements: PC with Windows™ 3.1 or Windows 95™, minimum 486/66 processor, 16 MB RAM, 12 MB hard disk (full installation), CD-ROM (for installation only). Chicago: Critical Concepts Inc; 1997. $74.

Sym*Bio*Sys Arterial Blood Gas (ABG) Interpretation is a program designed for in-depth education on arterial blood gas analysis. The software consists of two parts: an on-line, primarily textual, tutorial and a simulation engine that allows modification of the various physiologic parameters that determine gas exchange. The goal of **Sym*Bio*Sys ABG** is to provide instruction on ABG analysis at a wide range of levels with an intended audience that includes respiratory therapists, pulmonary function laboratory technicians, nurses, medical students, and physicians. The software largely meets this goal; however, the material rapidly reaches a sophisticated discussion of the underlying physiology of gas exchange and acid-base equilibrium that seems most appropriate for medical students and physicians. If the goal is a basic review on ABG interpretation, then the cost of the software may not be justified.

Sym*Bio*Sys ABG comes with a rudimentary printed User's Guide; however, the intuitive interface and on-line help make more extensive documentation unnecessary. The software loads quickly and without difficulty on a Pentium computer using the Windows 95™ operating system (OS) and on a Power PC computer running Macintosh OS 8.1 with Virtual PC emulation software. The **Sym*Bio*Sys ABG** interface uses a split screen. On the right side is the textual information including lessons and quizzes. On the left side is a tool window that presents case histories and lets you explore the effect of manipulating various physiologic parameters on gas exchange.

*Available from Critical Concepts Incorporated, 225 North Michigan Avenue, Suite 2522, Chicago IL 60601-7601, or at their web site: www.laketech.com. Discount prices for multi-user packs are available.

The first chapter of the tutorial contains four sections and provides an overview of ABG interpretation. The material presented is at a rudimentary level and is appropriate for novices to blood gas interpretation. The different blood gas parameters are defined, "panic values" are identified, and a simple, algorithmic approach for interpreting blood gas results is introduced in the context of clinical case scenarios. Hypertext links provide thorough documentation of the terminology used in blood gas analysis. At the end of each section in this and other chapters is a quiz to test one's knowledge of the presented material. Users who have some experience with ABG interpretation will want to move quickly through the first chapter.

The second chapter reviews the physiology of gas exchange and transport. The chapter begins with discussions of how oxygen and carbon dioxide are carried in the blood, including a thorough review of the oxygen: hemoglobin dissociation curve. Hyperlinks to simulation tools allow the user to experiment with the oxygen and carbon dioxide dissociation curves to better understand the effect of hemoglobin, temperature, and P_{CO_2} or P_{O_2} on arterial O_2 and CO_2 content. Subsequent sections include excellent discussions on the role of ventilation, ventilation: perfusion matching, shunt, and dead space on gas exchange. All of these sections include links to simulations, allowing users to familiarize themselves with the effect of each topic on gas exchange. These sections also introduce clinical examples of how the specific topic is relevant. These are generally good; however, I felt that the choice of emphysema to illustrate dead space was not the best. The explanation that alveoli are destroyed and leave large empty airspaces is misleading in that large bullae do not receive significant ventilation relative to their volume. A better explanation may have included discussions on destruction of capillary beds and reductions in vital capacity despite constant anatomic dead space. Even better, the authors might have used thromboembolic disease as an example of vascular occlusion causing dead space.

The third chapter of **Sym*Bio*Sys ABG** is an extremely in-depth review of acid-base physiology. This chapter does an excellent job of reviewing the role of carbon dioxide in acid-base regulation. All of the reactions of carbon dioxide in blood are discussed, including the chloride shift into red blood cells associated with an acute respiratory acidosis. Unfortunately, this chapter spends far too much time on a review of the strong ion difference (SID) and the role of proteins in acid-base regulation. The SID may be a more precise method of characterizing metabolic acid-base status; however, methods such as the base excess and bicarbonate concentration combined with anion gap (AG) are simpler and provide clinically relevant information. The user with a clinical bent may quickly get discouraged working through the explanations of electrolyte regulation and how the principle of electroneutrality is applicable. Nonetheless, for the user who wants a very in-depth understanding of acid-base regulation, this chapter is an excellent resource.

The final chapter puts all the previous lessons together to develop an algorithm for blood gas interpretation. The mechanisms of hypoxemia are reviewed and methods to differentiate ventilation:perfusion mismatch from shunt are discussed. Primary respiratory and metabolic acid-base disorders are reviewed and methods for evaluating compensatory responses are discussed. Finally, in Section 4.7, the AG is introduced as a method of evaluating clinical causes of metabolic acidosis. Unfortunately, the discussion is brief, leaving out such points as the ΔAG for evaluating mixed disorders.

The second part of **Sym*Bio*Sys ABG** consists of the simulation tools accessible in the left window. The tools include dissociation curves for oxygen and carbon dioxide, an alveolar gas tool that looks at effect of minute ventilation on alveolar gas composition, a shunt tool, a gamblegraph for electrolyte balance, and a variety of acid-base diagrams. All of these tools are interactive, allowing the user to move to different positions, for example, on a dissociation curve or a Davenport diagram. Most of the tools have multiple inputs to evaluate the effect of different parameters, eg, temperature on the oxygen-hemoglobin curve or altitude on the alveolar gas composition. These tools are linked to relevant sections within the tutorial. The simulation part of the software con-

tains a series of case scenarios for the user to work through as well as a speed drill function for ABG interpretation. Finally, the simulator allows users to make their own case scenarios including accurate blood gases. This, unfortunately, is the only place in the simulator where the effect of ventilation:perfusion mismatch may be independently specified as the standard deviation of the perfusion weighted ventilation:perfusion histogram. This ability to quickly generate ABGs that are accurate from an acid-base standpoint would be extremely useful when making exam or study questions for a respiratory physiology class.

Overall, **Sym*Bio*Sys ABG** is an effective tutorial on blood gas interpretation. The sections are well written and comprehensive. Typographical errors are relatively common but for the most part do not cause confusion. Exceptions include at least one erroneous quiz answer and a fluctuating equation for the upper limit of the alveolar-arterial oxygen difference as a function of age. The chapter on acid-base status spends far too much time on chemistry and too little time on more clinically useful analysis techniques. This program would be most useful as an adjunct to respiratory physiology classes for medical students or for the individual user who wants an in-depth knowledge of blood gas interpretation.

William A Altemeier MD
Senior Pulmonary Fellow
Pulmonary and Critical Care Medicine
University of Washington Medical Center
Seattle, Washington

A Practical Approach to Pulmonary Medicine, Ronald H Goldstein MD, James J O'Connell MD, & Joel B Karlinsky MD, editors. Illustrated, 605 pages. Philadelphia: Lippincott Raven; 1997. $59.95.

The preface to this text, whose editors are faculty members of the Boston University School of Medicine, indicates its intended readership as that of practicing primary care physicians and internists involved in the diagnosis and management of pulmonary diseases. The structure of the book reflects a simple format, with each chapter dealing with an aspect of pulmonary medicine. The foreword to this book by David M Center MD recommends its presentation for use as material for medical students and house officers and its insights as useful to all practitioners in pulmonary medicine. From an overall perspective I found this to be an excellent, straightforward, easy-to-use text with appropriate application to internal medicine, family practice, and pulmonary medicine. While the title includes the word 'practical,' which might suggest a limited review, this, in fact, is not true of this text, which provides a very complete review of the majority of topics involved in pulmonary medicine. I found it easy to follow with pertinent clinical points that were easy to identify. It is my general sense that the authors and editors have achieved their stated goal. The foreword portion of this book indicates that the senior authors of all the chapters were faculty and graduates of the Boston University teaching programs; however, I found on review of Chapter 6 that both of the stated authors were senior fellows rather than faculty members.

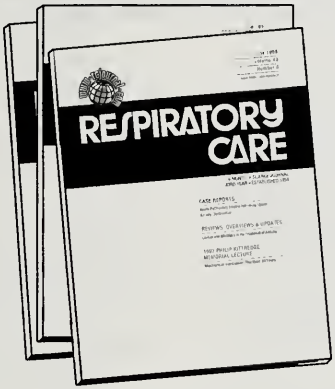
The authorship of this text is diverse; however, each author has some relationship to the Boston University School of Medicine; and the text, therefore, reflects the approaches of care practiced in that institution.

The topics are multiple and include specific areas of interest to the respiratory care clinician, including pulmonary function testing, asthma, emphysema, chronic bronchitis and bronchiectasis, cystic fibrosis, pulmonary rehabilitation, smoking cessation, oxygen therapy, and home care of the respiratory patient. Recommendations for therapy are up-to-date and reflect current references. The overall approach is quite clear, readable, and provides straightforward analysis of topics, many of which could not be reviewed in a short period of time.

I was particularly impressed with the excellent review of community acquired pneumonia in Chapter 6, which provides an exhaustive and up-to-date review even to the level of the practice of a pulmonologist and infectious disease specialist. Chapter 2, which includes the pulmonary function testing component, likely exceeds the intended practical approach by including such concepts as transdiaphragmatic pressure, closing volume, and static deflation volume-pressure curves. I did feel that the concepts of simple spirometry and flow volume loops could have been expanded to include examples, because these tests are more readily available to most primary care physicians.

The text is soft bound and with its rather significant coverage of current topics is very well priced. The authors and editors have done an excellent job. This would be an excellent book to be purchased and maintained by all respiratory care departments, but likely not necessary for the individual respiratory care clinician's personal library.

James D Pike DO
Pulmonary Associates
Indianapolis, Indiana



CRCE through the Journal—1998

CRCE through the Journal, a program for American Association for RESPIRATORY CARE (AARC) members to gain credit for continuing education, is now in its ninth year. By reading RESPIRATORY CARE—the science journal for respiratory care professionals—and completing this examination, AARC members may earn credit for continuing education.*

This 50-item, multiple-choice examination is based on papers published from July 1997 through June 1998 in RESPIRATORY CARE. The issue and page numbers of the paper on which a question is based are shown in brackets following the question. You may consult the cited paper; however, we *encourage* you to read the paper in its entirety before answering the question. Choose the single most-correct answer, and mark the answer sheet, which is located following Page 680.

Mail your completed answer sheet by October 31, 1998. Answer sheets postmarked after October 31 will not be processed. The Answer Key for ***CRCE for the Journal*** will be published in the November issue of RESPIRATORY CARE. No scores will be available from the AARC until the 1998 CRCE Transcripts are mailed in early 1999.

We are indebted to Crystal L Dunlevy EdD RRT, Visiting Associate Professor, Georgia State University, Atlanta, Georgia, for coordinating and writing the examination and to her co-authors: Vijay Deshpande MA RRT CPFT, Assistant Professor; Lynda Thomas Goodfellow MBA RRT, Director of Clinical Education; Robert Harwood MSA RRT, Assistant Professor; and Jonathan B Waugh PhD RRT CPFT, Assistant Professor, Georgia State University, Atlanta, Georgia.

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*The acceptance of these credits for the fulfillment of license-mandated continuing education is dictated solely by the licensure law of each individual state.

Questions:

Please follow the instructions on the previous page, and record your answers on the perforated form provided following page 680.

1. In the study by Fiser et al which of the following was found to be true?

   a. Although measured work of breathing (WOB) was increased with the isolation valve in place, oxygen consumption remained unchanged.
   b. Pressure-time-product (PTP) measurements remained unchanged with or without the isolation valve but WOB changed significantly.
   c. Subject WOB was calculated by integrating the area of an esophageal pressure and tidal-volume loop.
   d. Although the isolation valve does increase WOB it must remain in the patient circuit to protect caregivers from infection.
   e. Mean WOB and mean PTP both fell outside their 95% confidence intervals.
   [July 1997;42(7):688–692]

2. Results from the study by Shelledy and Smith comparing the I-STAT system to the Corning 278 include:

   a. The I-STAT system can be used as an acceptable alternative for analysis of pH, P_{aCO_2}, and P_{aO_2}.
   b. The I-STAT system can be used as an acceptable alternative for analysis of pH and P_{aCO_2}.
   c. The I-STAT system can be used as an acceptable alternative for analysis of pH only.
   d. The I-STAT system can be used as an acceptable alternative for analysis of P_{aO_2} only.
   e. The I-STAT system can be used as an acceptable alternative for analysis of pH, P_{aCO_2} and P_{aO_2} if at least 2 mL of blood is obtained for analysis.
   [July 1997;42(7):693–697]

3. Avant, Lowe, and Torres reported a budget savings of $232,000 that was achieved by

   a. reducing surgical pulse oximetry measurements.
   b. using reusable pulse oximetry probes.
   c. limiting the number of patients monitored postoperatively with pulse oximetry.
   d. changing to a less expensive pulse oximetry probe.
   e. substituting arterial blood gas measurements with pulse oximetry measurements in children <3 years of age.
   [July 1997;42(7):698–704]

4. MacKinnon et al found that

   a. the metabolic cart should not be used for patients receiving mechanical ventilation and $F_{IO_2} > 0.60$.
   b. in-vitro validations of the metabolic cart have reported a 10–12% mean error.
   c. changes in V_D/V_T do not occur with variations in respiratory pattern.
   d. the metabolic cart is as accurate as the Douglas-bag method for determining V_D/V_T.
   e. the Douglas-bag method has no sources of error in the measurement of P_{ECO_2}.
   [August 1997;42(8):761–764]

5. Emad describes bronchoalveolar lavage (BAL) as having an important role in the diagnosis of nosocomial pneumonia specifically in patients with which one of the following pulmonary disorders?

   a. *Mycobacterium tuberculosis*
   b. cancer
   c. asthma
   d. acute respiratory distress syndrome
   e. hypersensitivity pneumonitis
   [August 1997;42(8):765–790]

6. Which one of the following is **not** a possible complication of fiberoptic bronchoscopy reported in Emad's review of bronchoalveolar lavage?

   a. pneumonia
   b. cardiac arrhythmia
   c. pulmonary hemorrhage
   d. pneumothorax
   e. bronchospasm
   [August 1997;42(8):765–790]

7. According to Emad, detection of *Pneumocystis carinii* pneumonia (PCP) using polymerase chain reaction in bronchoalveolar lavage

   a. is ineffective at best and may expose the patient to unnecessary trauma.
   b. also reveals the presence of encysted sporozoites better than methanamine-silver nitrate.

c. should be reserved for those AIDS patients who have negative results on BAL cytologic examinations but are judged to have PCP on clinical grounds.
d. should be the first line of detection, followed by Gram-Weigert staining if DNA amplification is inconclusive.
e. is 100% effective for diagnostic purposes.
[August 1997;42(8):765–790]

8. According to Hoberty's national survey on inclusion of multiskilled education in the curricula of respiratory therapy programs, which of the following areas of skill are taught in more than 50% of the programs?

a. polysomnography, Holter monitoring, hemodynamic monitoring, bronchoscopy
b. exercise stress tests, extracorporeal membrane oxygenation, electroencephalography, bronchoscopy
c. bronchography, Holter monitoring, chest radiograph procedures, bed making, ambulating patients
d. I.V. infusions, electroencephalography, continuous positive airway pressure, titration, phlebotomy
e. automated blood tests, cardiac rehabilitation, exercise stress testing, electroencephalography
[September 1997;42(9):849–853]

9. Hagus examined respiratory care professionals' (RCPs) perceptions of education needs related to implementation of respiratory care protocols and reported that a large percentage of RCPs surveyed were in agreement with all but which of the following statements?

a. Implementation of respiratory care protocols will decrease utilization of RCPs.
b. The primary obstacle in implementing respiratory care protocols will be physician acceptance of the protocols.
c. Overall productivity and job security will suffer if potential protocols are implemented.
d. In order to implement these protocols, RCPs need to be retrained in x-ray and pulmonary function testing interpretations.
e. RCPs are adequately trained to administer respiratory care protocols.
[September 1997;42(9):858–863]

10. In order to improve admission criteria, Standridge, Boggs, and Mugan studied the reliability of the Health Occupations Aptitude Examination (HOAE). Their findings indicate which of the following?

a. The HOAE is the most reliable instrument to predict a student's program success.
b. The HOAE offers a method to advise a student on the appropriate allied health profession for him or her.
c. Although the pilot study results were inconclusive, HOAE provides an additional component along with other standard test scores to improve admission criteria.
d. The American College Test and high school grade point average are adequate to predict a student's program success.
e. A battery of tests still need to be developed in order to ascertain guaranteed program success.
[September 1997;42(9):868–872]

11. In describing their experience with distance learning education, Mishoe and associates identified certain limitations and made recommendations for slide preparation. Based on their experience, which of the following statements is incorrect?

a. A bold, large font size with a slight shadow should be used.
b. Unexpected inclement weather can pose a problem in implementing distance education.
c. Walking around, rather than standing at one place, while delivering distance education increases attention from the audience.
d. Distance education involves multiple sites for the attendees while the presenter delivers a topic using an interactive technology.
e. Precise communication with local coordinators and, if needed, the ability to modify content are essential in delivering distance education.
[September 1997;42(9):873–879]

12. According to the study by Kollef et al, which was the only variable under consideration found to be statistically significant for independently predicting a diagnosis of lung infection?

a. lung injury score
b. APACHE II score
c. endotoxin concentration in bronchoalveolar (BAL) fluid >5 EU/mL
d. the percent of neutrophils in BAL fluid
e. P_{aO_2}/F_{IO_2}
[October 1997;42(10):935–945]

13. In their study of predictors of lung infection, Kollef et al concluded that further study must be done to determine whether early diagnosis of lung infection could result in which of the following?

    a. restricted antimicrobial prescribing practices and improved patient outcomes
    b. significant decreases in hospitalization costs
    c. reduced number of false-negative and false-positive bronchoalveolar (BAL) test results
    d. lower lung injury scores during the course of the disease
    e. lower APACHE II scores during the course of the disease
    [October 1997;42(10):935–945]

14. Winter, Pike, and Dillard reported which of the following from a bench study of the Adult Star Ventilator measuring maximum inspiratory pressure (MIP) and pressure in the occluded airway at 0.1 seconds of tidal inspiration ($P_{0.1}$)?

    a. The patients tested produced significantly different MIP and $P_{0.1}$ values when PEEP was applied.
    b. Statistically significant differences observed were deemed to be clinically insignificant by the authors.
    c. Measuring $P_{0.1}$ with the Adult Star ventilator requires precise timing by the respiratory care provider.
    d. One-year-old ventilators were compared to a brand new ventilator of the same model for measurement accuracy.
    e. One-way valves added to measure MIP in the Adult Star ventilators created no significant errors in measurement.
    [October 1997;42(10):946–951]

15. In their comparison of pressure and flow triggering in several ventilators, Holbrook and Guiles found which of the following to be true regarding the use of bias flow?

    a. The addition of bias flow caused a significant increase in most ventilator response times.
    b. The Servo 300 response time remained faster than the other brands tested regardless of whether bias flow was used.
    c. In the normal subjects tested, the Puritan-Bennett 7200 ventilator was quicker to respond than other ventilators in pressure-trigger mode when small endotracheal tube sizes were used in the presence of bias flow.
    d. Bias flow has a detrimental effect on ventilator response even if the sensitivity is adjusted to the patient's condition.
    e. Flow triggering significantly improves ventilator response time when bias flow is present.
    [October 1997;42(10):952–959]

16. In a comparative study by Branson, Campbell, and Davis, which of the following was stated?

    a. Expiratory airflow had no effect on moisture output of either passive humidifier tested.
    b. Heat and moisture exchangers (HME) use both physical and chemical properties to retain and exchange moisture.
    c. The findings of Eckerbom and Lindholm (1990) strongly agreed with a similar study by Branson et al (1996) using the ISO 9360 test method.
    d. The effect of increasing expiratory flow causing decreased moisture output is amplified when low dead-space devices are used.
    e. Patients with low pulmonary compliance are likely to benefit by receiving a higher moisture content from a passive humidifier than specified by the manufacturer.
    [October 1997;42(10):960–964]

17. Giles et al developed a triage rating instrument used interobserver concordance in order to establish

    a. a correlation between observers.
    b. content validity of the instrument.
    c. face validity of the instrument.
    d. construct validity of the instrument.
    e. reliability of the triage rating instrument.
    [October 1997;42(10):965–973]

18. The triage score as developed by Giles et al incorporates all of the following except

    a. frequency of therapy.
    b. identification of patients whose respiratory care needs are minimal.
    c. clinical outcomes, such as ICU transfer rates and nosocomial pneumonia occurrences.
    d. a patient's pulmonary history, surgical status on current admission, and chest radiograph findings.
    e. the ability to cough, breath sounds, respiratory pattern, and level of activity on direct observation.
    [October 1997;42(10):965–973]

19. In the review by Quintiliani, inhaled fluticasone propionate has been reformulated, since U.S. Food and Drug Administration approval was granted, to a

    a. 10% lecithin suspension.
    b. 5% lecithin suspension.
    c. 2% lecithin suspension.
    d. 1% lecithin suspension.
    e. 0.1% lecithin suspension.
    [October 1997;42(10):974–979]

20. Quintiliani's review of the literature found that the use of inhaled fluticasone propionate (FP) and beclomethasone dipropionate (BDP) in the treatment of asthma resulted in

    a. little difference in the two drugs in terms of the maximum degree of improvement of asthma symptoms.
    b. no difference in peak expired flow rates (PEFR) between the use of FP and BDP.
    c. BDP posing a larger risk to the hypothalamus, pituitary, and adrenal glands (the HCA axis) function than FP.
    d. no difference in the systemic activity of FP and budesonide (BUD).
    e. the need for mouth rinsing following the use of FP because there is no systemic absorption of FP.
    [October 1997;42(10):974–979]

21. Which of the following statements best describes the outcome of the comparative study by Bowers and associates on resting energy expenditure (REE) values obtained by indirect calorimetry and the Harris-Benedict equation (HBE) in HIV-infected men of normal body weight?

    a. Indirect calorimetric measurement is economically superior to the HBE method.
    b. HBE yields an underestimated REE value; thus over time may result in weight loss and decrease in immune function in patients with HIV.
    c. As long as the patient is not overweight, REE calculated by HBE is consistent with that obtained by indirect calorimetry.
    d. HBE needs to be modified for HIV-infected patients by a factor of 206 kcal/d.
    e. An extra 10% of energy intake should be assumed when REE is calculated by HBE.
    [November 1997;42(11):1018–1021]

22. An in vitro study by Blanch and Banner demonstrated the clinical value of tracheal pressure ventilator control (TPVC) and compared it with that of pressure support ventilation (PSV). Which of the following statements is incorrect in reference to TPVC?

    a. TPVC delivers variable pressure-assist in accordance with patient ventilatory demands.
    b. The study indicates that regardless of the inspiratory flow and volume demands, measured imposed work of breathing (WOB_I) was minimal compared to continuous positive airway pressure and PSV.
    c. Under most conditions, TPVC provided significantly higher PIFR than an equivalent, manually set level of PSV.
    d. TPVC is a superior form of pressure-assist than PSV.
    e. Clinically, TPVC and manually-set PSV provide pressure-assist of the same efficiency.
    [November 1997;42(11):1022–1033]

23. In their review of the use of heliox for treatment of airflow obstruction, Manthous and colleagues recommend heliox therapy in which clinical situation?

    a. early intervention in an asthmatic patient
    b. during acute, severe exacerbation of bronchial asthma
    c. exacerbation of chronic obstructive pulmonary disease (COPD)
    d. as an intermediate trial in an exacerbated status asthmaticus patient before instituting tracheal intubation and mechanical ventilation
    e. as a powering gas for nebulization of bronchodilators in asthmatic patients
    [November 1997;42(11):1034–1041]

24. Which of the following was the outcome of the Hoffman and Smithline study on the comparison of Circulaire™ (C-Neb) to a conventional small volume nebulizer, Misty-Neb (M-Neb), for treatment of bronchospasm in the emergency department?

    a. C-Neb demonstrated statistically significant improvement in PEFR as compared with M-Neb group.
    b. M-Neb demonstrated statistically significant improvement in PEFR as compared with C-Neb group.
    c. The results were inconclusive due to variations in age groups.
    d. The C-Neb group indicated a significant increase in PEFR between the first and second treatments.
    e. Both nebulizers yielded similar results between the first and second treatments.
    [December 1997;42(12);1170–1173]

25. According to Kass, Gerber, Kartan et al, which of the following effects was noted on respiratory muscle strength secondary to plasmapheresis in patients with Gullian-Barré Syndrome?

    a. Only one plasmapheresis session was required to demonstrate improved muscle strength.
    b. As the plasmapheresis sessions were repeated, the patient's muscle strength deteriorated.
    c. A slow sequential improvement in respiratory muscle strength occurred following serial plasmapheresis sessions.
    d. Improvement in VC was much greater than the improvement in NIF.
    e. The study group and the control group demonstrated similar improvements in respiratory muscle strength.
    [December 1997;42(12):1175–1178]

26. In the study by Jager and Tweeddale, which of the following was shown to improve accuracy in pressure measurements during mechanical ventilation?

    a. Repeating measurements of P_{aw} at the proximal airway and taking the mean value.
    b. Measuring P_{trach} instead of P_{aw} when observing and following variations in pressures secondary to changes in lung mechanics.
    c. On average, P_{aw} values are almost equal to P_{trach} values.
    d. Increased P_{aw} values give a clear reflection of changes in lung mechanics.
    e. In all clinical situations P_{trach} can be accurately predicted from proximal airway pressures.
    [December 1997;42(12):1179–1183]

27. Myers et al found that pediatric asthma units staffed by respiratory therapists demonstrated

    a. no reduction in the number of school days missed between patients in the asthma care unit (ACU) and the control group.
    b. a significant reduction in care plan variances for patients in the ACU compared to the control group.
    c. an increase in the number of days of work missed by parents in the control groups compared to the ACU group.
    d. that seasonal variations significantly affected length of stay (LOS) when using asthma care paths.
    e. that respiratory therapists increase the costs of care for patients admitted to pediatric asthma care units.
    [January 1998;43(1):22–29]

28. In the Utstein style a cardiac arrest is defined as

    a. confirmation of no pulse, unresponsiveness, and apnea.
    b. any cardiac and pulmonary dysfunction that leads to hypotension, shock, and agonal breathing.
    c. incorporating descriptions of resuscitation emergencies and outcomes, including comorbid factors and effects of interventions already in place.
    d. the cessation of cardiac mechanical activity.
    e. the cessation of cardiac mechanical activity confirmed by the absence of a detectable pulse, unresponsiveness, and apnea (agonal respirations).
    [January 1998;43(1):33–59]

29. The Utstein Template System represents

    a. a population and subpopulations.
    b. a conceptual starting point to analyze resuscitation requests obtained in a hospital.
    c. a uniform display of possible outcomes.
    d. guidelines for reviewing, reporting, and conducting research on in-hospital resuscitation.
    e. all of the above.
    [January 1998;43(1):33–59]

30. The Utstein Style for reporting outcomes of in-hospital resuscitation includes all of the following ethical constructs except

    a. DNAR, no CPR, do not resuscitate.
    b. medical futility.
    c. resuscitation for organ donation.
    d. informed consent.
    e. appropriate incremental risk.
    [January 1998;43(1):33–59]

31. In Volsko's study of a pediatric asthma clinic program which of the following was not a finding?

    a. reduced emergency department visits
    b. reduced hospitalizations
    c. increase in patient and family compliance in keeping regularly scheduled appointments
    d. reduced hospitalization costs
    e. increase in compliance in keeping a diary of peak flow measurements
    [February 1998;43(2):107–113]

32. McCarthy and colleagues in their review of mechanically ventilated patients found that the greatest ventilator length of stay, cost, and mortality occurred in

    a. coronary care unit
    b. medical intensive care unit
    c. cardiothoracic intensive care unit
    d. surgical intensive care unit
    e. neurological intensive care unit
    [February 1998;43(2):114–118]

33. According to the National Lung Health Education program, all but which of the following have been identified as risk factors for chronic obstructive pulmonary disease (COPD)?

    a. occupational exposure to dusts
    b. childhood allergies
    c. air pollution
    d. cigarette smoking
    e. childhood respiratory tract infections
    [March 1998;43(3):185–208]

34. In the United States, chronic obstructive pulmonary disease (COPD) ranks as the _____ leading cause of death.

    a. 2nd
    b. 3rd
    c. 4th
    d. 5th
    e. 6th
    [March 1998;43(3):185–208]

35. According to the National Lung Health Education program, what can be said about the association between socioeconomic status and chronic obstructive pulmonary disease (COPD)?

    a. Mortality rates from COPD are higher among those with low family incomes.
    b. There is no relationship between COPD and socioeconomic status.
    c. COPD patients with blue collar jobs have lower mortality rates than their white collar counterparts.
    d. COPD mortality rates are higher for men with low family incomes, but not for women.
    e. COPD patients who have a high school education have similar mortality rates to those who have less than a high school education.
    [March 1998;43(3):185–208]

36. According to the National Lung Health Education program, spirometry can accomplish all but which of the following?

    a. assess lung health
    b. predict morbidity and mortality
    c. evaluate the effects of certain drugs
    d. predict heart health
    e. reinforce benefits associated with smoking cessation
    [March 1998;43(3):185–208]

37. The "tube law" described by Chediak details which of the following relationships?

    a. Snoring or other injury to the upper airway may lead to a local neuropathy and ultimately obstructive sleep apnea.
    b. Active exhalation shifts the airway compliance curve to the right.
    c. As body weight increases, tissue pressure decreases causing a decrease in lung volume.
    d. In women, the larger the lung volume relative to airway diameter, the greater the possibility of obstructive sleep apnea.
    e. Increases in transmural airway pressure increase the cross-sectional area of the passive upper airway.
    [April 1998;43(4):265–270]

38. Strohl points out that the risk factor of most concern in patients with sleep-disordered breathing that should be identified by physicians and health care personnel is

    a. snoring.
    b. hypoxemia.
    c. depression.
    d. apnea.
    e. sleepiness.
    [April 1998;43(4):277–282]

39. According to the article by Phillips, the peak years of prevalence for clinically significant obstructive sleep apnea is probably

    a. preteenage.
    b. teenage.
    c. 20s or 30s.
    d. 40s or 50s.
    e. 60s or 70s.
    [April 1998;43(4):288–291]

40. According to Minkley, center-based and home-based sleep testing

    a. inconsistently used terminology relating to sleep studies.
    b. are performed differently in terms of personnel, equipment used, and initial cost of the study.
    c. show no difference in the amount of education and follow-up available to patients following sleep testing.
    d. all of the above.
    e. none of the above.
    [April 1998;43(4):296–301]

41. Atwood suggests that the usual initial continuous positive airway pressure (CPAP) level for treatment of obstructive sleep apnea is

    a. 2 cm H_2O.
    b. 3 cm H_2O.
    c. 5 cm H_2O.
    d. 8 cm H_2O.
    e. 12 cm H_2O.
    [April 1998;43(4):307–304]

42. When using bi-level positive airway pressure to treat obstructive sleep apnea Atwood suggests the expiratory pressure is increased in increments of 2.5 cm H_2O until

    a. apneas are eliminated.
    b. obstructive hypopneas are reduced.
    c. inspiratory flow-limitation-associated arousals are reduced.
    d. snoring is eliminated.
    e. periods of hypoventilation are reduced.
    [April 1998;43(4):307–314]

43. In order for a patient to be optimally treated with continuous positive airway pressure (CPAP), which of the following must be true?

    a. proper CPAP titration
    b. therapist compliance
    c. patient acceptance
    d. a and b
    e. a and c
    [April 1998;43(4):318–321]

44. Patients who suffer from obstructive sleep apnea (OSA) should avoid conditions that may potentiate upper airway collapse. Such conditions include all but which of the following?

    a. cigarette smoking
    b. narcotics
    c. sedatives
    d. caffeine
    e. sleep deprivation
    [May 1998;43(5):370–375]

45. Brooks points out that although history and physical examination are important in suggesting obstructive sleep apnea in children the diagnosis must be confirmed by

    a. hematocrit to detect polycythemia.
    b. arterial blood gases to detect hypoxemia and hypercarbia.
    c. overnight polysomnography.
    d. echocardiogram to evaluate right heart strain.
    e. thyroid function testing.
    [May 1998;43(5):394–397]

46. According to Erman, managed care has impacted the practice of sleep disorders and sleep-related services. Which of the following was **not** a finding?

    a. a greater emphasis on limited studies for screening purposes
    b. split-night studies becoming the standard diagnostic approach
    c. studies which show that there are benefits associated with the treatment of sleep apnea beyond improvements in daytime sleepiness
    d. use of empiric continuous positive airway pressure in patients suspected of sleep apnea
    e. hospital-based sleep disorders centers moving to alternate sites
    [May 1998;43(5):401–407]

47. According to a study by Kallet and others, postobstructive pulmonary edema

    a. probably represents increased permeability pulmonary edema.
    b. most likely represents a hydrostatic form of pulmonary edema.
    c. may be representative of oncotic pulmonary edema.
    d. represents a low pressure form of pulmonary edema.
    e. is characterized by low PCWP.
    [June 1998;43(6):476–480]

48. All but which of the following are true about cysteinyl leukotrienes?

    a. They are more potent bronchoconstrictors than histamine.
    b. They are rapidly metabolized.
    c. They are rapidly eliminated.
    d. They constrict the airways of asthmatic subjects in vivo.
    e. They do not constrict the airways of normal subjects in vivo.
    [June 1998;43(6):481–489]

49. The first-line medication for treatment of chronic airway inflammation is

    a. zafirlukast.
    b. zileuton.
    c. inhaled corticosteroids.
    d. cromolyn sodium.
    e. long-acting bronchodilators.
    [June 1998;43(6):481–489]

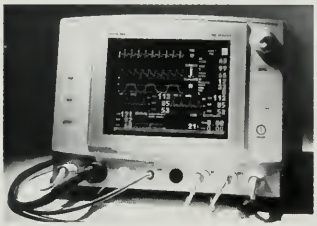
50. According to MacIntyre, which of the following statements represents a major trend in mechanical ventilation?

    a. The aging population is declining.
    b. The need for mechanical ventilation will steadily decrease over the next several years.
    c. Chronic ventilator dependence has resulted in an increased number of subacute and long-term ventilator facilities.
    d. The ICU is still the most cost-effective way to care for ventilator-dependent patients.
    e. We deliver less aggressive medical care than we did 20 years ago.
    [June 1998;43(6):490–493]

New Products & Services

News releases about new products and services will be considered for publication in this section. There is no charge for these listings. Send descriptive release and glossy black and white photographs. to RESPIRATORY CARE, New Products & Services Dept. 11030 Ables Lane, Dallas TX 75229-4593. The Reader Service Card can be found at the front of the Journal.

Cardiac Assessment Tool. The Electromedical Systems Division of Siemens Medical Systems Inc introduces the Infinity Telemetry™ System. This is a cardiac assessment tool that provides a complete view of a patient's electrocardiogram (ECG) status from all points of care, the company says. The assessment tool is part of the Infinity Monitoring System and provides real-time 7-lead ECG monitoring with integrated S_{pO_2} monitoring and 7-lead ST segment analysis options. For more information from Siemens Medical Inc, circle number 160 on the Reader Service card in this issue, or send your request electronically via "Advertisers Online" at http://www.aarc.org/buyers_guide/.



Monitor for Magnetic Resonance Imaging. Datascope has released its MR Monitor, a vital signs monitor to be used with magnetic resonance imaging (MRI). According to company literature, the device provides uninterrupted monitoring throughout the patient's MRI and is compatible with MRI systems now in clinical use. The monitor is nonradiant with fiber optic electrocardiogram (ECG) and S_{pO_2} leads. The device measures ECG, heart rate, S_{pO_2}, dual invasive blood pressure, capnography, N_2O, F_{IO_2}, and anesthetic agents. For more information from Datascope, circle number 161 on the Reader Service card in this issue, or send your request electronically via "Advertisers Online" at http://www.aarc.org/buyers_guide/.

Peak Flow Meter & Log Book. Ferraris Medical Inc introduces the AM1 Asthma Monitor®. This tool may be used by the physician for outcome monitoring of asthma and chronic obstructive pulmonary disease patients and may contribute to improved self management by the patient. According to literature by the manufacturer, the AM1 measures and stores important expiratory flow volume variables including peak flow, forced volume capacity, forced expiratory volume after 1 second. Each measurement is classified to help the patients monitor their condition. An integrated electronic diary allows the patient to register data, and the physician can access and evaluate the information from an office workstation via AMOS (asthma monitor software made for use with AM1) at a later time. For more details about the AM1, circle number 163 on the Reader Service card in this issue, or send your request electronically via "Advertisers Online" at http://www.aarc.org/buyers_guide/.

Portable Oxygen System. Chad Therapeutics Inc releases the Total O_2 delivery system. This system combines PSA-stationary technology with the Oxylite portable oxygen system. The manufacturer says that this system allows patients to fill the portable cylinder from a stationary source. For more details about the Total O_2 delivery system contact Chad Therapeutics Inc by circling number 162 on the Reader Service card in this issue, or send your request electronically via "Advertisers Online" at http://www.aarc.org/buyers_guide/

MEDWATCH

THE FDA MEDICAL PRODUCTS REPORTING PROGRAM

For VOLUNTARY reporting by health professionals of adverse events and product problems

Page ___ of ___

Form Approved: OMB No. 0910-0291 Expires: 4/30/96
See OMB statement on reverse

FDA Use Only (Resp Care)

Triage unit sequence #

A. Patient information

Patient identifier

In confidence

2. Age at time of event: or Date of birth:

3. Sex ☐ female ☐ male

4. Weight ___ lbs or ___ kgs

B. Adverse event or product problem

☐ Adverse event and/or ☐ Product problem (e.g., defects/malfunctions)

Outcomes attributed to adverse event (check all that apply)

☐ death ___ (mo/day/yr)
☐ life-threatening
☐ hospitalization – initial or prolonged
☐ disability
☐ congenital anomaly
☐ required intervention to prevent permanent impairment/damage
☐ other: ___

Date of event (mo/day/yr)

4. Date of this report (mo/day/yr)

Describe event or problem

Relevant tests/laboratory data, including dates

Other relevant history, including preexisting medical conditions (e.g., allergies, race, pregnancy, smoking and alcohol use, hepatic/renal dysfunction, etc.)

C. Suspect medication(s)

1. Name (give labeled strength & mfr/labeler, if known)
#1
#2

2. Dose, frequency & route used
#1
#2

3. Therapy dates (if unknown, give duration) from/to (or best estimate)
#1
#2

4. Diagnosis for use (indication)
#1
#2

5. Event abated after use stopped or dose reduced
#1 ☐ yes ☐ no ☐ doesn't apply
#2 ☐ yes ☐ no ☐ doesn't apply

6. Lot # (if known)
#1
#2

7. Exp. date (if known)
#1
#2

8. Event reappeared after reintroduction
#1 ☐ yes ☐ no ☐ doesn't apply
#2 ☐ yes ☐ no ☐ doesn't apply

9. NDC # (for product problems only)
– –

10. Concomitant medical products and therapy dates (exclude treatment of event)

D. Suspect medical device

1. Brand name

2. Type of device

3. Manufacturer name & address

4. Operator of device
☐ health professional
☐ lay user/patient
☐ other: ___

5. Expiration date (mo/day/yr)

6.
model # ___
catalog # ___
serial # ___
lot # ___
other #

7. If implanted, give date (mo/day/yr)

8. If explanted, give date (mo/day/yr)

9. Device available for evaluation? (Do not send to FDA)
☐ yes ☐ no ☐ returned to manufacturer on ___ (mo/day/yr)

10. Concomitant medical products and therapy dates (exclude treatment of event)

E. Reporter (see confidentiality section on back)

1. Name & address

phone #

2. Health professional? ☐ yes ☐ no

3. Occupation

4. Also reported to
☐ manufacturer
☐ user facility
☐ distributor

5. If you do NOT want your identity disclosed to the manufacturer, place an " X " in this box. ☐

FDA

Mail to: MEDWATCH
5600 Fishers Lane
Rockville, MD 20852-9787

or FAX to:
1-800-FDA-0178

FDA Form 3500 1/96)

Submission of a report does not constitute an admission that medical personnel or the product caused or contributed to the event.

ADVICE ABOUT VOLUNTARY REPORTING

Report experiences with:

- medications (drugs or biologics)
- medical devices (including in-vitro diagnostics)
- special nutritional products (dietary supplements, medical foods, infant formulas)
- other products regulated by FDA

Report SERIOUS adverse events. An event is serious when the patient outcome is:

- death
- life-threatening (real risk of dying)
- hospitalization (initial or prolonged)
- disability (significant, persistent or permanent)
- congenital anomaly
- required intervention to prevent permanent impairment or damage

Report even if:

- you're not certain the product caused the event
- you don't have all the details

Report product problems – quality, performance or safety concerns such as:

- suspected contamination
- questionable stability
- defective components
- poor packaging or labeling
- therapeutic failures

How to report:

- just fill in the sections that apply to your report
- use section C for all products except medical devices
- attach additional blank pages if needed
- use a separate form for each patient
- report either to FDA or the manufacturer (or both)

Important numbers:

- 1-800-FDA-0178 to FAX report
- 1-800-FDA-7737 to report by modem
- 1-800-FDA-1088 to report by phone or for more information
- 1-800-822-7967 for a VAERS form for vaccines

If your report involves a serious adverse event with a device and it occurred in a facility outside a doctor's office, that facility may be legally required to report to FDA and/or the manufacturer. Please notify the person in that facility who would handle such reporting.

Confidentiality: The patient's identity is held in strict confidence by FDA and protected to the fullest extent of the law. The reporter's identity, including the identity of a self-reporter, may be shared with the manufacturer unless requested otherwise. However, FDA will not disclose the reporter's identity in response to a request from the public, pursuant to the Freedom of Information Act.

The public reporting burden for this collection of information has been estimated to average 30 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to:

DHHS Reports Clearance Office
Paperwork Reduction Project (0910-0291)
Hubert H. Humphrey Building, Room 531-H
200 Independence Avenue, S.W.
Washington, DC 20201

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service • Food and Drug Administration

FDA Form 3500-back

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Public Health Service
Food and Drug Administration
Rockville, MD 20857

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MEDWATCH
The FDA Medical Products Reporting Program
Food and Drug Administration
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Rockville, MD 20852-9787

American Association for Respiratory Care

MEMBERSHIP APPLICATION

Please read the eligibility requirements for each of the classifications in the right-hand column, then complete the applicable section. All information requested below must be provided, except where indicated as optional. See other side for more information and fee schedule. Please sign and date application on reverse side and type or print clearly. Processing of application takes approximately 15 days.

- ☐ Active
  - Associate
    - ☐ Foreign
    - ☐ Physician
    - ☐ Industrial
- ☐ Special
- ☐ Student

Last Name _____

First Name _____

Social Security No. _____

Home Address _____

City _____

State _____ Zip __ __ __ __ __-__ __ __ __

Phone No. (_____) _____

Primary Job Responsibility (check one only)

- ☐ Technical Director
- ☐ Assistant Technical Director
- ☐ Pulmonary Function Specialist
- ☐ Instructor/Educator
- ☐ Supervisor
- ☐ Staff Therapist
- ☐ Staff Technician
- ☐ Rehabilitation/Home Care
- ☐ Medical Director
- ☐ Sales
- ☐ Student
- ☐ Other, specify _____

Type of Business

- ☐ Hospital
- ☐ Skilled Nursing Facility
- ☐ DME/HME
- ☐ Home Health Agency
- ☐ Educational Institution
- ☐ Manufacturer or supplier
- ☐ Other, specify _____

Date of Birth (optional) _____ Sex (optional) _____

U.S. Citizen? ____ Yes ____ No

Have you ever been a member of the AARC? _____

If so, when? From _____ to _____

Preferred mailing address: ☐ Home ☐ Business

For office use only

FOR ACTIVE MEMBER

An individual is eligible if he/she lives in the U.S. or its territories or was an Active Member prior to moving outside its borders or territories, and meets ONE of the following criteria: (1) is legally credentialed as a respiratory care professional if employed in a state that mandates such, OR (2) is a graduate of an accredited educational program in respiratory care, OR (3) holds a credential issued by the NBRC. An individual who is an AARC Active Member in good standing on December 8, 1994, will continue as such provided his/her membership remains in good standing

PLEASE USE THE ADDRESS OF THE LOCATION WHERE YOU PERFORM YOUR JOB, NOT THE CORPORATE HEADQUARTERS IF IT IS LOCATED ELSEWHERE.

Place of Employment _____

Address _____

City _____

State _____ Zip __ __ __ __ __-__ __ __ __

Phone No. (_____) _____

Medical Director/Medical Sponsor _____

FOR ASSOCIATE OR SPECIAL MEMBER

Individuals who hold a position related to respiratory care but do not meet the requirements of Active Member shall be Associate Members. They have all the rights and benefits of the Association except to hold office, vote, or serve as chair of a standing committee. The following subclasses of Associate Membership are available: Foreign, Physician, and Industrial (individuals whose primary occupation is directly or indirectly devoted to the manufacture, sale, or distribution of respiratory care equipment or supplies). Special Members are those not working in a respiratory care-related field

PLEASE USE THE ADDRESS OF THE LOCATION WHERE YOU PERFORM YOUR JOB, NOT THE CORPORATE HEADQUARTERS IF IT IS LOCATED ELSEWHERE.

Place of Employment _____

Address _____

City _____

State _____ Zip __ __ __ __ __-__ __ __ __

Phone No. (_____) _____

FOR STUDENT MEMBER

Individuals will be classified as Student Members if they meet all the requirements for Associate Membership and are enrolled in an educational program in respiratory care accredited by, or in the process of seeking accreditation from, an AARC-recognized agency

SPECIAL NOTICE — Student Members do not receive Continuing Respiratory Care Education (CRCE) transcripts. Upon completion of your respiratory care education, continuing education credits may be pursued upon your reclassification to Active or Associate Member.

School/RC Program _____

Address _____

City _____

State _____ Zip __ __ __ __ __-__ __ __ __

Phone No. (_____) _____

Length of program

- ☐ 1 year
- ☐ 2 years
- ☐ 4 years
- ☐ Other, specify _____

Expected Date of Graduation *(REQUIRED INFORMATION)*

Month _____ Year _____

American Association for Respiratory Care • 11030 Ables Lane • Dallas, TX 75229-4593 • (972) 243-2272 • Fax (972) 484-2720

Demographic Questions

We request that you answer these questians in order to help us design services and programs to meet your needs.

Check the Highest Degree Earned

- ☐ High School
- ☐ RC Graduate Technician
- ☐ Assaciate Degree
- ☐ Bachelor's Degree
- ☐ Master's Degree
- ☐ Doctorate Degree

Number of Years in Respiratory Care

- ☐ 0-2 years
- ☐ 3-5 years
- ☐ 6-10 years
- ☐ 11-15 Years
- ☐ 16 years ar mare

Job Status

- ☐ Full Time
- ☐ Part Time

Credentials

- ☐ RRT
- ☐ CRTT
- ☐ Physician
- ☐ CRNA
- ☐ RN
- ☐ LVN/LPN
- ☐ CPFT
- ☐ RPFT
- ☐ Perinatal/Pediatric

Salary

- ☐ Less than $10,000
- ☐ $10,001-$20,000
- ☐ $20,001-$30,000
- ☐ $30,001-$40,000
- ☐ $40,000 ar mare

PLEASE SIGN

I hereby apply for membership in the Americon Associotion for Respirotory Care and hove enclosed my dues. If opproved for membership in the AARC, I will abide by its bylows ond professional code of ethics. I authorize investigation of oll stotements contoined herein ond understond thot misrepresentotions or omissions of facts colled for is couse for rejection or expulsion.

A yearly subscription to RESPIRATORY CARE journal ond *AARC Times* magazine includes an allocotion of $11.50 from my dues for eoch of these publicotions.

NOTE: Contributions or gifts to the AARC ore not tox deductible os charitoble contributions for income tox purpases. However, they may be tax deductible as ordinory ond necessory business expenses subject to restrictions imposed os o result of association lobbying activities The AARC estimotes that the nondeductible portion of your dues — the portion which is allocable to lobbying — is 26%.

Signature _____

Date _____

Membership Fees

Payment must accompany your application to the AARC. Fees are for 12 months. (NOTE: Renewal fees are $75.00 Active, Associate-Industrial or Associate-Physician, or Special status; $90.00 for Associate-Foreign status; and $45.00 for Student status).

☐ Active	$ 87.50
☐ Associate (Industrial or Physician)	$ 87.50
☐ Associate (Fareign)	$102.50
☐ Special	$ 87.50
☐ Student	$ 45.00
TOTAL	$_____

Specialty Sections

Established to recognize the specialty areas of respiratory care, these sectians publish a bi-monthly newsletter that facuses on issues of specific concern to that specialty. The sections also design the specialty programming at the national AARC meetings.

☐ Adult Acute Care Section	$15.00
☐ Education Section	$20.00
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☐ Subacute Care Section	$15.00
TOTAL	$_____

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To charge yaur dues, complete the following:

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- ☐ Visa

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Card Expires _____/_____

Signature _____

Mail application and appropriate fees to:
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RESPIRATORY CARE

Manuscript Preparation Guide

General Information

RESPIRATORY CARE welcomes original manuscripts related to the science and technology of respiratory care and prepared according to these Instructions and the *Uniform Requirements for Manuscripts Submitted to Biomedical Journals* [Respir Care 1997; 42(6):623-634]. Manuscripts are blinded and reviewed by professionals who are experts in their fields. Authors are responsible for all aspects of the manuscript and receive galleys to proofread before publication. Each accepted manuscript is copyedited so that its message is clear and it conforms to the Journal's style. Published papers are copyrighted by Daedalus Inc and may not be published elsewhere without permission.

Editorial consultation is available at any stage of planning or writing. On request, specific guidance is provided for all publication categories. To receive these Instructions and related materials, write to RESPIRATORY CARE, 600 Ninth Avenue, Suite 702, Seattle WA 98104, call (206) 223-0558, or fax (206) 223-0563.

Publication Categories & Structure

Research Article: A report of an original investigation (a study). It includes a Title Page, Abstract, Introduction, Methods, Results, Discussion, Conclusions, Product Sources, Acknowledgments, References, Tables, Appendices, Figures, and Figure Captions.

Evaluation of Device/Method/Technique: A description and evaluation of an old or new device, method, technique, or modification. It has a Title Page, Abstract, Introduction, Description of Device/Method/Technique, Evaluation Methods, Evaluation Results, Discussion, Conclusions, Product Sources, Acknowledgments, References, Tables, Appendices, Figures, and Figure Captions. Comparative cost data should be included wherever possible.

Case Report: A report of a clinical case that is uncommon, or was managed in a new way, or is exceptionally instructive. All authors must be associated with the case. A case-managing physician must either be an author or furnish a letter approving the manuscript. Its components are Title Page, Abstract, Introduction, Case Summary, Discussion, References, Tables, Figures, and Figure Captions.

Review Article: A comprehensive, critical review of the literature and state-of-the-art summary of a pertinent topic that has been the subject of at least 40 published research articles. Title Page, Outline, Introduction, Review of the Literature, Summary, Acknowledgments, References. Tables, Appendices, and Figures and Captions may be included.

Overview: A critical review of a pertinent topic that has fewer than 40 published research articles.

Update: A report of subsequent developments in a topic that has been critically reviewed in this Journal or elsewhere.

Point-of-View Paper: A paper expressing personal but substantiated opinions on a pertinent topic. Title Page, Text, References, Tables, and Illustrations may be included.

Special Article: A pertinent paper not fitting one of the foregoing categories may be acceptable as a Special Article. Consult with the Editor before writing or submitting such a paper.

Editorial: A paper drawing attention to a pertinent concern; it may present an opposing opinion, clarify a position, or bring a problem into focus.

Letter: A signed communication, marked "For publication," about prior publications in this Journal or about other pertinent topics. Tables and illustrations may be included.

Blood Gas Corner: A brief, instructive case report involving blood gas values—with Questions, Answers, and Discussion.

Drug Capsule: A mini-review paper about a drug or class of drugs that includes discussions of pharmacology, pharmacokinetics, and pharmacotherapy.

Graphics Corner: A brief case report incorporating waveforms for monitoring or diagnosis—with Questions, Answers, and Discussion.

Kittredge's Corner: A brief description of the operation of respiratory care equipment—with information from manufacturers and editorial comments and suggestions.

PFT Corner: Like Blood Gas Corner, but involving pulmonary function tests.

Cardiorespiratory Interactions. A case report demonstrating the interaction between the cardiovascular and respiratory systems. It should be a patient-care scenario; however, the case—the central theme—is the systems interaction. CRI is characterized by figures, equations, and a glossary. See the March 1996 Issue of RESPIRATORY CARE for more detail.

Test Your Radiologic Skill: Like Blood Gas Corner, but involving pulmonary medicine radiography and including one or more radiographs; may involve imaging techniques other than conventional chest radiography.

Review of Book, Film, Tape, or Software: A balanced, critical review of a recent release.

Preparing the Manuscript

Print on one side of white bond paper, 8.5 in. x 11 in. (216 x 279 mm) with margins of at least 1 in. (25 mm) on all sides of the page. Use ***double-spacing*** throughout the ***entire*** manuscript. Use a standard font (eg, Times, Helvetica, or Courier) at least 10 points in size, and

do not use italics except for special emphasis. Number all pages in upper-right corners. Indent paragraphs 5 spaces. Do ***not justify***. **Do *not* put authors' names, institutional affiliations or allusions to institutional affiliations in the text, or other identification anywhere except on the title page.** Repeat title only (no authors) on the abstract page. Begin each of the following on a new page: Title Page, Abstract, Text, Product Sources List, Acknowledgments, References, each Table, and each Appendix. Use standard English in the first person and active voice.

Center main section headings on the page and type them in capital and small letters (eg, Introduction, Methods, Results, Discussion). Begin subheadings at the left margin and type them in capital and small letters (eg, Patients, Equipment, Statistical Analysis).

References. Cite only published works as references. Manuscripts accepted but not yet published may be cited as references: designate the accepting journal, followed by (in press), and provide 3 copies of the in-press article for reviewer inspection. Cite references in the text with superscript numerals. Assign numbers in the order that references are first cited. On the reference page, list the cited works in numerical order. Follow the Journal's style for references. Abbreviate journal names as in *Index Medicus*. List all authors.

Article in a journal carrying pagination throughout volume:

> Rau JL, Harwood RJ. Comparison of nebulizer delivery methods through a neonatal endotracheal tube: a bench study. Respir Care 1992;37(11):1233-1240.

Article in a publication that numbers each issue beginning with Page 1:

> Bunch D. Establishing a national database for home care. AARC Times 1991;15(Mar):61,62,64.

Corporate author journal article:

> American Association for Respiratory Care. Criteria for establishing units for chronic ventilator-dependent patients in hospitals. Respir Care 1988;33(11):1044-1046.

Article in journal supplement: (Journals differ in their methods of numbering and identifying supplements. Supply sufficient information to promote retrieval.)

> Reynolds HY. Idiopathic interstitial pulmonary fibrosis. Chest 1986; 89(3 Suppl):139S-143S.

Abstract in journal: (Abstracts citations are to be avoided. Those more than 3 years old should not be cited.)

> Stevens DP. Scavenging ribavirin from an oxygen hood to reduce environmental exposure (abstract). Respir Care 1990;35(11): 1087-1088.

Editorial in journal:

> Enright P. Can we relax during spirometry? (editorial). Am Rev Respir Dis 1993;148(2):274.

Editorial with no author given:

> Negative-pressure ventilation for chronic obstructive pulmonary disease (editorial). Lancet 1992;340(8833):1440-1441.

Letter in journal:

> Aelony Y. Ethnic norms for pulmonary function tests (letter). Chest 1991;99(4):1051.

Paper accepted but not yet published:

> Hess D. New therapies for asthma. Respir Care (year, in press).

Personal author book: (For any book, specific pages should be cited whenever possible.)

> DeRemee RA. Clinical profiles of diffuse interstitial pulmonary disease. New York: Futura; 1990. p. 76-85.

Corporate author book:

> American Medical Association Department of Drugs. AMA drug evaluations, 3rd ed. Littleton CO: Publishing Sciences Group; 1977.

Chapter in book with editor(s):

> Pierce AK. Acute respiratory failure. In: Guenter CA, Welch MH, editors. Pulmonary medicine. Philadelphia: JB Lippincott; 1977:26-42.

Tables. Use consecutively numbered tables to display information. Start each table on a separate page. Number and title the table and give each column a brief heading. Place explanations in footnotes, including all nonstandard abbreviations and symbols. Key the footnotes with conventional designations (*, †, ‡, §, ||, ¶, **, ††) in consistent order, placing them superscript in the table body. Do not use horizontal or vertical rules or borders. Do not submit tables as photographs, reduced in size, or on oversize paper. Use the same typeface as in the text.

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Calendar of Events

AARC & AFFILIATES

August 21—*Ohio Society*
The Critical Care Committee, annual seminar to be held at the Holiday Inn Rockside Road, Independence, Ohio.
CRCE: 6 credits.
Contact: Nancy Johnson at (330) 929-7166 or abbyru@aol.com.

August 28—*Alaska Society*
Multidisciplinary Asthma Protocols, featuring speaker Bob Demers RRT, Providence Anchorage Medical Center, Anchorage, Alaska. The education seminar is sponsored by the ASRC and Health Scan Corporation.
Contact: Wayne Wallace RRT at (907) 486-9517 or e-mail wwallace@ptialaska.net.

September 11–13—*AARC Patient Assessment Course*
The course will be offered at the Clarion International Quality Inn at O'Hare, Chicago, Illinois.
CRCE: 16 hours
Contact: Preregistration is required, call (972) 243-2272.

October 8—*New York Society, Southeastern Chapter*
30th Annual Symposium at the Marriott Marquis in Manhattan, New York. AARC Executive Director Sam Giordano MBA RRT will speak on "The RCP: Practice in the 21st Century." Also, the NYSSRC and SUNY Stony Brook will be hosting a clinical assessment workshop Oct. 9–10 at the Cornell Club in Manhattan.
Contact: (516) 444-3181 or www.nyssrc.org.

October 9—*Colorado Society, Southern Chapter*
5th Annual Southern Colorado Pulmonary Medicine Symposium at the Holiday Inn Garden of the Gods, Colorado Springs, Colorado.
Contact: Cathy Fletchall at (719) 776-5025 or Barry Beard at (719) 776-5212.

October 17—*Alaska Society*
"Fall Lung Conference and Meeting" at Providence Anchorage Medical Center, Anchorage, Alaska. Sponsored by the ASRC, Dräger, Nellcor Puritan Bennett, and SensorMedics.
Contact: Wayne Wallace RRT at (907) 486-9517 or e-mail wwallace@ptialaska.net.

November 7–10—*International Respiratory Congress*
The American Association for Respiratory Care hosts its 44th annual International Respiratory Congress at the Georgia World Congress Center in Atlanta, Georgia. More than 7,000 people will experience programs appealing to all levels of health care providers—from clinicians to managers and administrators, to manufacturers and distributors of equipment and supplies. Program content will include neonatal, pediatric, and adult critical care; acute, continuing, and rehabilitative care; diagnostics; management; and case and disease management—a comprehensive program on respiratory care. Exhibits by all manufacturers of cardiopulmonary equipment in the world will be featured.
Contact: For program brochure and registration information, contact the AARC at 11030 Ables Lane, Dallas, TX 75229-4593; (972) 243-2272; fax (972) 484-2720; e-mail meetings@aarc.org; or visit the web site at www.aarc.org.

OTHER MEETINGS

August 19–23—*Clinical Laboratory Management Association*
22nd Annual Conference and Exhibition at the Pennsylvania Convention Center in Philadelphia, Pennsylvania.
Contact: (610) 995-9580 or visit www.clma.org.

August 26—*Cleveland Clinic Foundation*
"Respiratory Therapy Consult Service" in conjunction with "Horizons in Pulmonary and Critical Care Medicine." This program will be held at Bunts Auditorium at The Cleveland Clinic, Cleveland, Ohio.
CRCE: Category 1 accreditation has been received.
Contact: Nancy Robbins, program coordinator, at (216) 444-8356; fax (216) 445-9406.

September 17–18—*Association for the Advancement of Medical Instrumentation & the U.S. Food & Drug Administration*
Medical Device Servicing, Remarketing, and Refurbishing: Is Regulation Needed? The conference will provide a foundation for the formulation of a public health policy decision regarding the regulation of these activities. The conference will be held at the Sheraton Reston in Reston, Virginia.
Contact: AAMI at (800) 332-2264 ext 260 or www.aami.org.

June 12–16, 1999—*International Society for Aerosols in Medicine*
12th International Congress at the Austria Center in Vienna, Austria.
Contact: Vienna Academy of Postgraduate Medical Education and Research, Alser Strasse 4, A-1090 Vienna, Austria. Phone (+43/1) 405 13 83-22, fax (+43/1) 405 13 83-23, e-mail medacad@via.at.

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Notices of competitions, scholarships, fellowships, examination dates, new educational programs, and the like will be listed here free of charge. Items for the Notices section must reach the Journal 60 days before the desired month of publication (January 1 for the March issue, February 1 for the April issue, etc). Include all pertinent information and mail notices to RESPIRATORY CARE Notices Dept. 11030 Ables Lane, Dallas TX 75229-4593.

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— American Respiratory Care Foundation fellowships, grants, & awards
— Clinical Practice Guidelines

National Board for Respiratory Care
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The American College of Chest Physicians
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RRT Examination	December 5, 1998	250 Both (new applicant)
	Application Deadline: August 1, 1998	210 Both (reapplicant)
RPFT Examination	December 5, 1998	180 (new applicant)
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NAMES Education & Conference Schedule

The National Association for Medical Equipment Services (NAMES) announces its 1998 national conferences and regional education seminars. For information about upcoming events, call the NAMES Education & Meeting Department at (703) 836-6263, or visit the web site: www.names.org.

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The American Association for Respiratory Care's web site contains important information about fellowships, scholarships, and research grants. International fellowships, education scholarships, research fellowships, and other grand programs are described in detail. The site also contains information about the $1,000,000 Research Fund, a restricted fund to sponsor research initiatives that document the clinical and economic impact of respiratory care professionals in the delivery of health care. To apply, a "Research Plan Abstract" must be submitted to the AARC by October 1, 1998. To find out more about these programs, log on at **www.aarc.org.**

Year 2000 Date Problem Addressed by FDA

On June 24, 1998, the Food and Drug Administration announced the availability of the document, "Guidance on FDA's Expectations of Medical Device Manufacturers Concerning the Year 2000 Date Problem." The document is available via telephone (800) 899-0381 or (301) 827-0111 or via the Internet at www.fda.gov/cdrh/yr2000/y2kguide.html.

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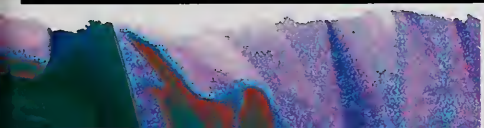

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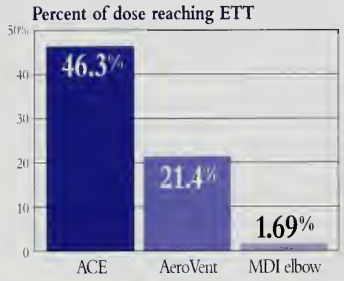

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